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Engineering News-Record

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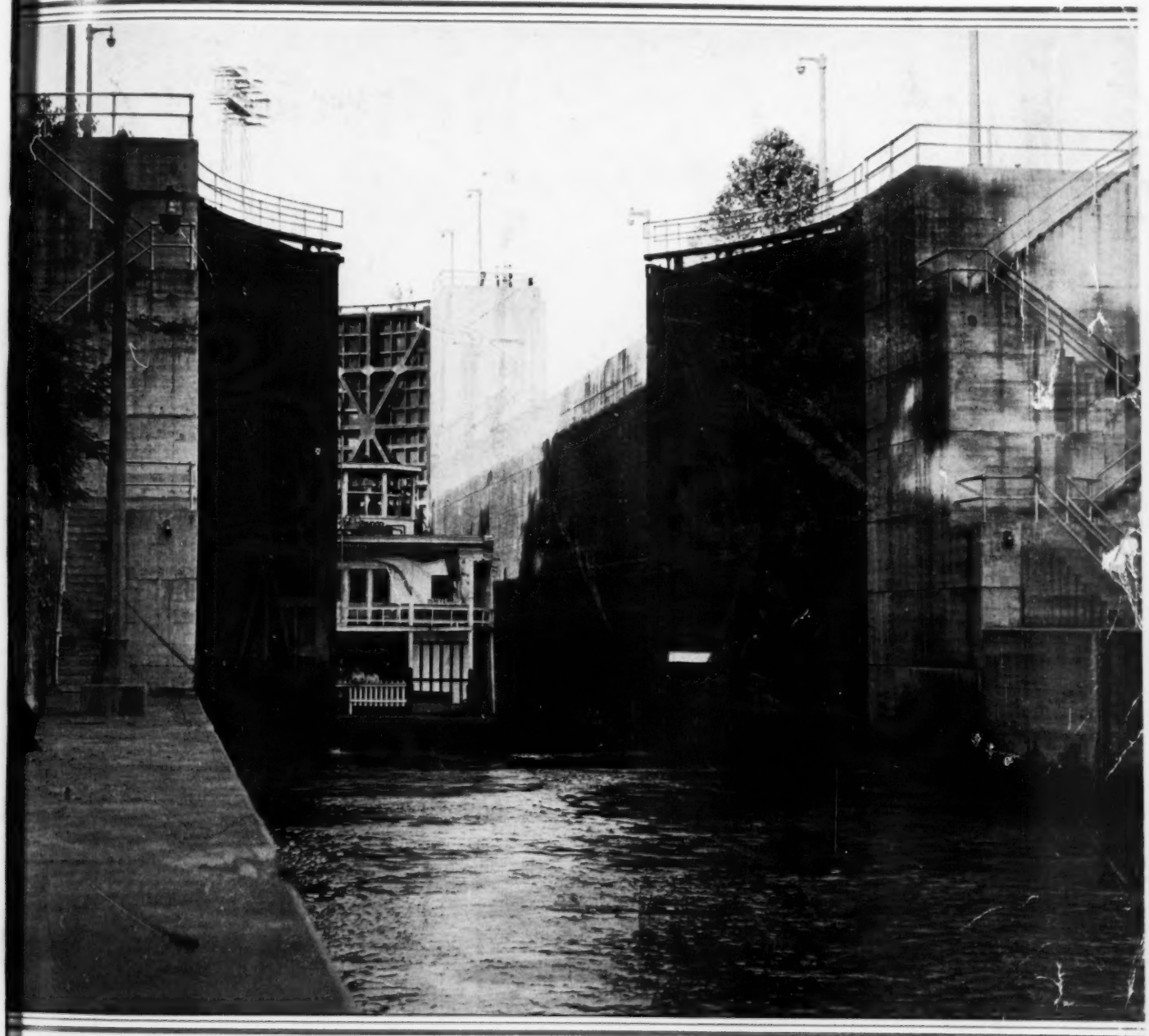

Modernization of the canal system of the Tennessee River began with construction of locks at Wilson Dam

Wide Use of Asphalt on Wyoming Roads . . . How Army Engineers Keep Costs . . . Navigation and Power on the Tennessee River . . . Road Planning for the Future . . . S... ...ted by Radio . . . Federal Aid for Stream Pollution . . . River Crossing ... ...ipe

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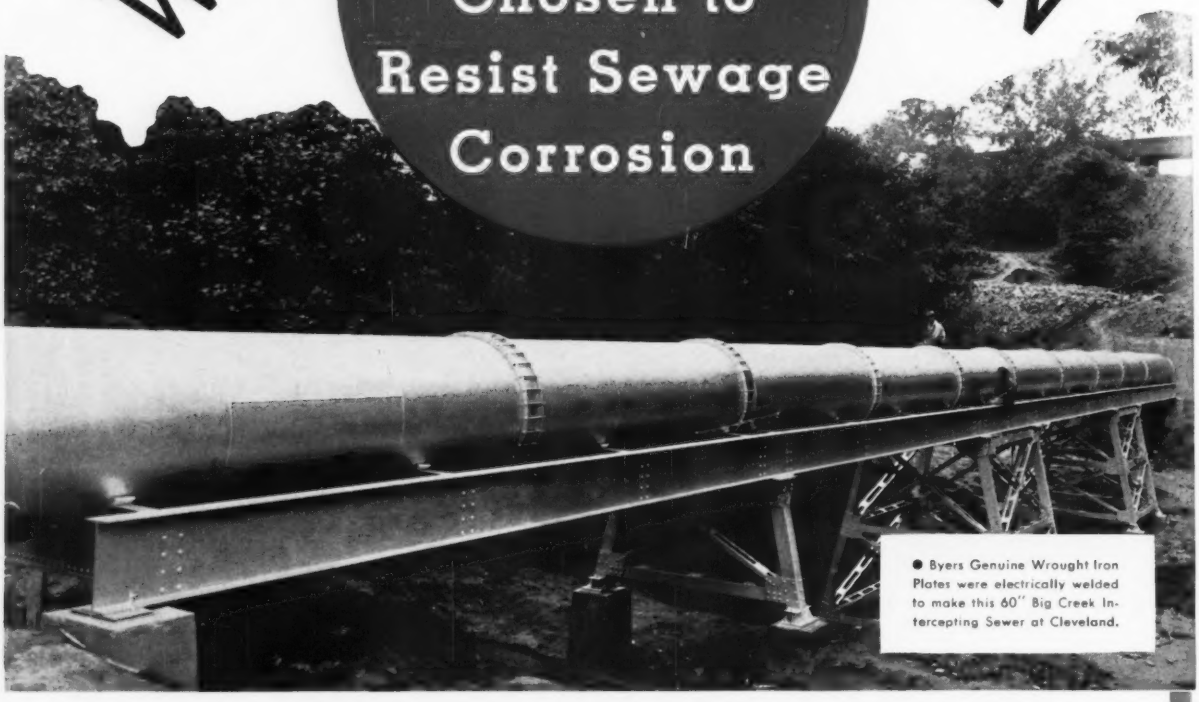
Chosen to Resist Sewage Corrosion



● Byers Genuine Wrought Iron Plates were electrically welded to make this 60" Big Creek Intercepting Sewer at Cleveland.

● The fact that many leading engineers choose wrought iron for sewage handling equipment — and the fact that wrought iron is longer-lived and more economical in this service—has many times been sufficient reason for using wrought iron to resist other similar types of corrosion.

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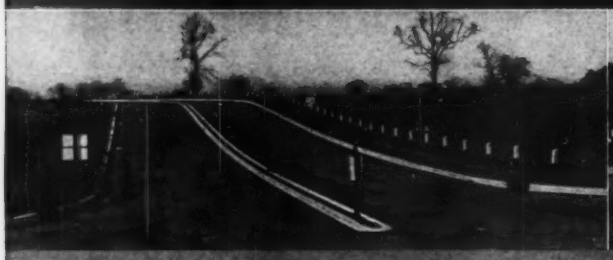
A Significant Statement—Thomas H. MacDonald, Chief of the U. S. Bureau of Public Roads, speaking to the state highway officials convention in San Francisco last week, set forth his views as to the direction in which road planning should go in this country. Because of his position, Mr. MacDonald's statement is peculiarly significant. It is reproduced nearly in full in this issue.

Age cannot dim these permanent white curbs made with Atlas White portland cement.



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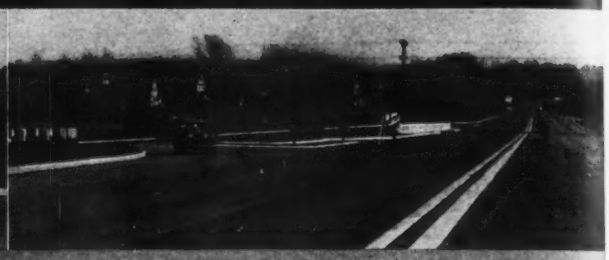

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ATLAS WHITE PORTLAND CEMENT FOR MARKERS AND CURBS

ENGINEERING NEWS-RECORD

December 17, 1936

IN WYOMING the mileage of improved roads has been increased from 351 to 2,510 in five years by treating the surface with asphaltic oils.

Asphalt is King on Wyoming Roads

Five types of bituminous surfaces designed to meet different soil requirements and traffic volumes have become established practice

FIVE TYPES of road, all using asphalt oils, compose the main paved system of Wyoming. In 1931, 351 mi. of state highways were of oil-surfaced or a higher type, while on Jan. 1, 1936, 2,510 miles were so surfaced out of a total of 3,573 mi. in the system. All of the interstate trunk roads have an oiled surface; in fact, with the exception of about 10 mi., all the highways in the state which in 1935 carried an average of 250 or more vehicles per day, are oiled; all state highways in four counties are oiled. Thus the state has 70 per cent of its system out of the mud, an achievement much more speedily accomplished than by most of the eastern states. Necessarily costs have been kept low and the bituminous types used are those born of necessity in the intermountain states, utilizing roadside materials and the natural products of the region.

Wyoming is part of the western plateau which abuts against the Rocky Mountains and is partially traversed by them. It consists of flat or gently-rolling uplands from 5,000 to 7,000 ft. in elevation with occasional eroded buttes and mesas. Much of the state is of these high plains, but the main chain of the Rockies extends southeast from Yellowstone Park and passes into Colorado midway of the southern boundary of the state. Thus the state has plenty of mountain roads especially expensive to keep open in the winter. The easiest northern pass over the Continental Divide is in Wyoming.

State attractions capitalized

All this territory is replete with records of happenings during pioneer travel over the Oregon, Mormon, California and Overland trails, as well as the route of the Pony Express. Near Casper is the locale of Owen Wister's "Virginian" and the Goose Egg ranch, where the cowboys in his novel exchanged the babies. This is on the road from Casper to Alcova Dam, now under construction. The ranch is marked by a roadhouse but the abandoned original stone ranch house is on a dirt road some distance off the main oiled road. As the 60-mi. main canal of the Casper-Alcova irrigation project passes by the ranch a new generation of farmer-pioneers will soon occupy the land again and call for the development of paved roads on squared lines to replace the present winding cattle trails of dust or mud.

Between Cheyenne and Laramie the Lincoln Highway reaches its highest elevation, 8,835 ft., as it crosses Sherman Hill, famous as the source of disintegrated granite, the ballast for the Union Pacific all the way to Omaha. The present road system makes accessible the natural scenic attractions of Yellowstone Park, the living glaciers of the Big Horn Mountains, the Medicine Bow and Wind River ranges, the great field of fossilized skeletons and petrified forests near Medicine Bow, and serves the closely settled irrigated areas watered from mountain streams and the Shoshoni and Pathfinder reservoirs. Workable coal seams extend under more than 41,000 sq. mi., 42 per cent of the area of the state. A dozen oil fields, including Salt Creek and

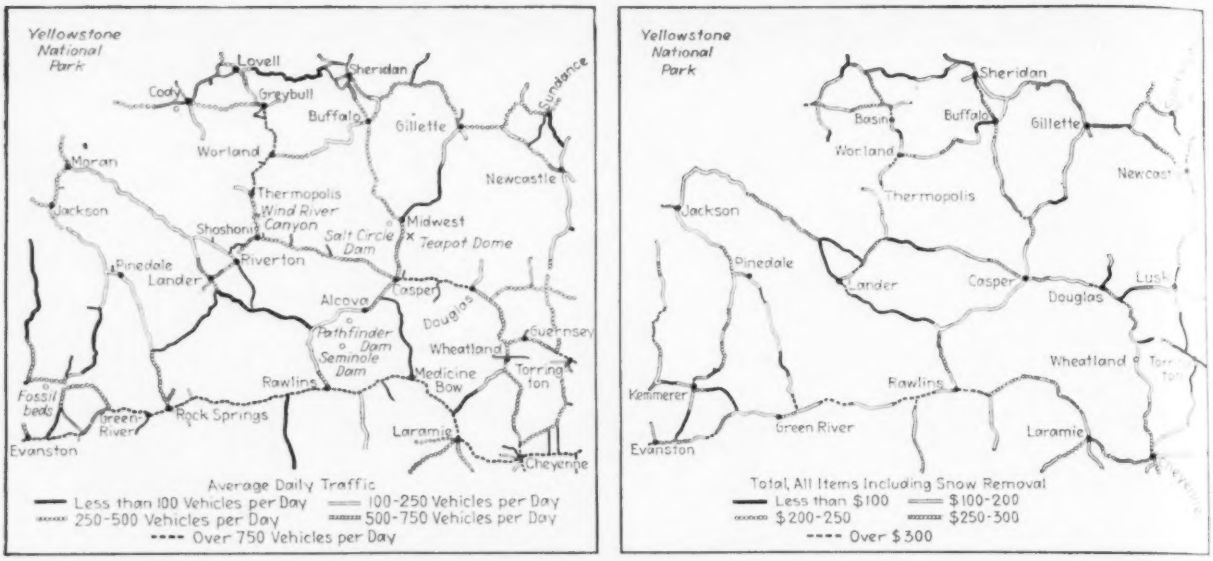


FIG. 2—TWO STATE ROAD MAPS are prepared annually by Wyoming highway engineers: (1) showing density of traffic and (2) showing cost of maintenance per mile. From them it is determined where improved surfaces are needed.

FIG. 3—SNOW REMOVAL is more persistently demanded each year, and in the heavy snowfall year of 1935 its cost was 17 per cent of the total maintenance expenditure

Teapot Dome, benefited in 1935 from the highway program, as more than 10,000,000 gal. of road oil and cutback asphalt were used on 306 mi. of highway at a cost of $1,200,000. Climate in Wyoming is characterized by a clear, dry air with relatively low humidity tempering the cold of winter and heat of summer, highly conducive to resort development, but producing special road problems.

In general Wyoming, like Montana, as noted in *Engineering News-Record*, Sept. 3, 1936, p. 337, is one of the stock-raising sparsely-settled states where distances are great and funds meager. With a population of 230,000 occupying 98,000 sq. mi. the density drops to 2.3 persons per sq. mi. and 64 persons per lin. mi. of highway, whereas Illinois has 790 persons per mi. of its 10,000-mi. system. Three main routes cross the state from the east to west, the principal one being the Lincoln Highway (Route 30) from Cheyenne to Evanston. The second enters the state at Torrington from the east and follows up the North Platte River through Casper and on to Yellowstone Park. The third route, much less direct than the others, ranges through the northern tier of counties and after serving cattle ranch areas of the eastern plains contacts irrigated areas and the dude ranch districts of the northern and northwestern parts of the state, winding up as the eastern or Cody entrance to Yellowstone Park. There are four or five more or less north and south roads, the principal one serving Cheyenne, Casper and Sheridan. An important north and south link passes through Riverton, Shoshoni, Thermopolis, Worland, Greybull and Lovell, touching several irrigated areas and through the famous Wind River canyon south of Thermopolis. All of these roads, which are the ones utilized by tourists to the national parks or the much-advertised dude ranches, are high-speed, smooth, dustless highways, the equal in travelability to a newly completed concrete slab of the more populous states.

The earnings of these more traveled roads through gas tax receipts have to produce enough revenue to care for themselves and to help out on the less frequently used roads. Nearly all of the 101 dude ranches and resorts catering to eastern recreation seekers, are located on these side roads. The out-of-state traffic on many of the main routes is 60 to 75 per cent of the total. Distribution and density of traffic as observed in 1935 by a traffic census is shown on the accompanying map (Fig. 2, left). By combining the information on this map with a similar one (Fig. 2, right) showing maintenance costs for the different sections, the engineers determine to what sections funds may most economically be allocated.

Up-to-date engineering

During 1935 the state highway departments held to a three-fold program of (1) bringing the existing trunks to a modern standard of grade, alignment, width and surface, (2) the construction of a reasonable mileage of additional main routes and (3) the construction of a considerable mileage of secondary roads so as to make the main roads of more use locally.

A policy of consistency has been adopted; grades and alignment called for in all projects put under contract, now and last year, are consistent with

the speed at which it is expected the vehicle using the road will be traveling. Standards are laid down for 45, 60 and 80 m.p.h. On heavier traveled roads a 24-ft. oiled mat is placed on a 36-ft. roadbed. It is felt that 12-ft. lanes are not too extravagant for a high-speed road. On secondary and feeder roads the 36-ft. roadbed becomes 26 ft. but a 30-ft. width is used on the major portion of the state system with 11 ft. as the absolute minimum width of traveled lanes.

Flat side slopes are used on light fills and wide shallow ditches are used in cut on all new construction lessening the chances of a car turning over should it leave the road.

Practically one-third of the expenditure of the last year has been made to eliminate danger spots. In addition grade crossing elimination has been undertaken intensively. Since 1917 when the department was organized, eighty-nine railroad crossings have been eliminated by relocation or separation. Only twenty-two mainline crossings are still in use, of which eight are being eliminated under the present program. Of these four are under contract and plans are being drawn for the other four. Several eliminations within cities are being built by the state. Seventeen flashing light signals are being installed to cut down accidents; these are either in cities or on the main highway. With the above program completed, every main-line grade crossing on the state highway system outside of cities will be protected or eliminated.

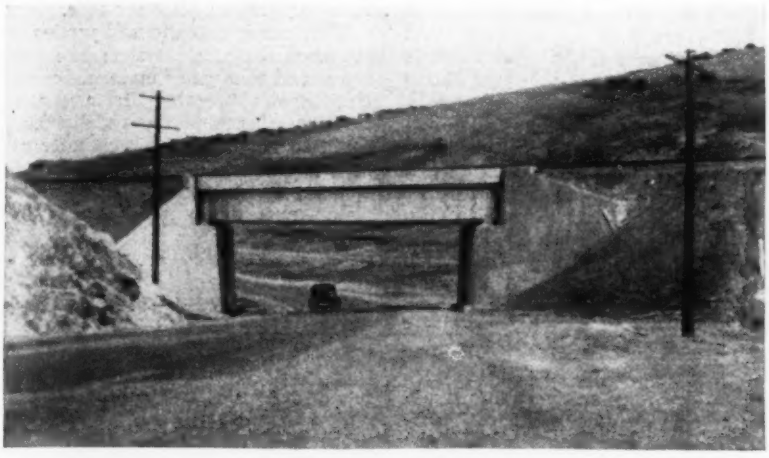


FIG. 4—ROAD-RAIL CROSSINGS have been eliminated in Wyoming until only 22 remain and eight of these are now being eliminated.

Five types of surfacing

A study has been made of the amount and character of the traffic along with the soil and moisture conditions of the territory through which the various roads are built. This was necessary so that the funds available would cover the mileage necessary to be oiled, to conserve the investment in gravel and to provide a usable surface. These studies, together with the experience gained by the engineers of the department, as well as the experience of other western states, led to the adoption of the following five types of construction, per mile costs of which are noted in Table I.

Group 1 is through territory where there is small rainfall and the soil is predominantly sandy. Traffic is light, the entire mileage being on secondary or intrastate roads. The essentials of construction technique consist of blading enough material from the surface to give a windrow of 2 sq. ft.; applying a penetration coat of MC-1 (kerosene cutback asphalt) of 0.3 gal. per sq.yd.; blading the windrow over the surface; application of 2-3 gal. of MC-2; mixing by blades or road-mix machines; spreading; rolling, and sealcoating with RC-1 (naptha cutback asphalt). As shown in Table I, and the cost runs $1,653 per mi., but on considerable of the mileage the cost was $1,440 per mile, the higher average being caused by using a 3-sq. ft. windrow on some of the work. A 1½ to 2-in. mat, 20 to 23 ft. wide, is obtained by this method.

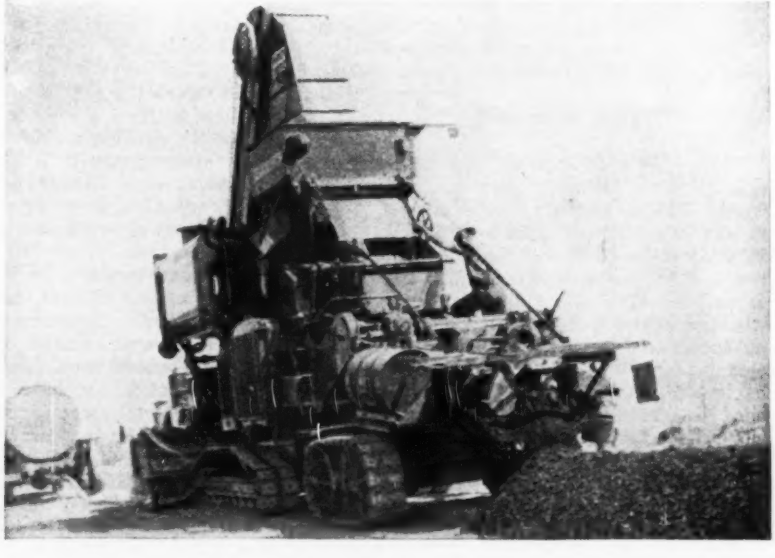
There is left 2 to 3 in. of gravel base course between the mat and the subgrade, which is composed of soil satisfactory for support of the load. In exceptional cases, where unsatisfactory soil is encountered, it is either removed and replaced by, or stabilized with, additional gravel. Coarse sub-base material is added where moisture conditions are detrimental. The cost of the subgrade reinforcement is not included in the costs given in the table.

Group 2 consists of projects where soil, moisture and traffic conditions indicate that a greater total thickness of top and base is required. The operations are the same as described for Group 1 except that 1,000 tons per mi. of new gravel is added and the windrow is in general 3 sq.ft. instead of 2 sq.ft., giving a correspondingly thicker mat with a $900 per mile increase in cost.

The projects listed in Group 3 are the standard road-mix type differing from the above in that enough gravel is added for a 6-sq.ft. windrow and no prime coat is used; SC-3 (slow curing road oil) is used and the result is a dense graded mat 2½ in. thick.

Group 4 has the same general characteristics as Group 3 except that medium-curing cutback asphalt is used in place of the slow-curing road oil. The use of the cutback instead of the road oil is in line with the trend toward the greater use of the cutback asphalt. Experience has shown that a stronger and more stable mat is obtained and while the asphalt itself costs more, and

FIG. 5—TRAVELING MACHINE mixing and spreading bituminous surfacing.



slightly more is needed for the same type of aggregate, the increased cost of $300 per mile is held to be justified.

These MC jobs have now been down at least a year and there have been no indications that the use of cutbacks with their lower viscosities will cause any appreciable amount of cracking from brittleness. The type of aggregate having a large percentage of crushed or angular particles seems adapted to this type of bituminous binder. Care is taken that the mat is not laid down until sufficient diluent has evaporated to stop any early softness and consequent rutting of the mat before the diluent has gone out. However, no great amount of so-called aeration was necessary.

Group 5 includes 24 mi. of surface constructed with crusher-run limestone which would come between the dense-graded and the open-graded type. On this account the rapid-curing type of asphaltic binder was used. The material was mixed in a traveling machine. After laying down, some choking with crusher fines or sand was required in connection with the seal coat to make the mat impervious. Excellent subgrade and drainage conditions are found on this work, but no gravel was available, hence the use of the rock which required the use of the RC-type of cutback. In consequence the $900 increased cost over the Group 4 type is chargeable to the absence of local gravel rather than to the necessity of a higher type of mat.

The costs per mile shown in the table are for 1935 work. The costs for this work let in 1936 are considerably higher, mainly on account of the increased oil prices. Officials are apprehensive that the increase in oil prices may defeat the purpose of using oiled roads, that is a large mileage of low-cost roads, and that some other method of getting dustless roads may have to be developed.

The change in the classification of road surfaces on the state system during the last five years is well illustrated in Table II where the earth road and oiled surfaces have exchanged places.

Upkeep is stressed

Taking into account all the maintenance items including snow removal, weeds, bridges, and other costs, as well as surface maintenance, the costs per mi. in 1935 were $195 per mi. for oiled roads, $209 for gravel and $175 for earth. At first glance the conclusion would be drawn that there is practically no reduction in the maintenance costs obtained by oiling. However, it should be borne in mind that in general the oiled roads are the heavily traveled roads while the traffic on gravel roads is fairly light, much of the mileage being in the mountains or in outlying districts which get the summer tourist traffic only. A better comparison would be to take one typical example from the detailed report which shows a maintenance cost of $43.74 per mile for an oiled road while an adjacent gravel road which is necessarily being oiled this year shows a maintenance cost of $427.27.

TABLE I. CONSTRUCTION COST PER MILE OF VARIOUS TYPES OF OILED ROADS IN WYOMING.

Materials	Groups 1	2	3	4	5
Prime coat, MC-1	$394	$302			
Aggregate		587	$1,138	$1,265	$2,144
SC-3			1,439		
MC-2	757	1,067		1,774	
RC-2					1,711
Seal Coat, RC-1	168	157	265	173	
Processing	334	432	701	624	851
Totals	$1,653	$2,545	$3,483	$3,836	$4,706
Miles represented	92	36	184	47	24

TABLE II. MILEAGE OF VARIOUS TYPES OF ROADS ON THE WYOMING STATE HIGHWAY SYSTEM.

Surface Type	Jan. 1, 1931	Jan. 1, 1933	Jan. 1, 1936
Earth	1,342	708	390
Gravel	1,431	1,294	673
Oil or higher type	351	1,387	2,510
Totals	3,124	3,389	3,573

Aside from snow-removal maintenance of Wyoming's state roads, costs were $160 per mile in 1935 as against $170 in 1934, all of the decrease being due to decreased surface expenditures. Various individual sections of oiled roads varied from $50 to $473 per mile with a single case at $837, where considerable reconstruction was done. From a study of the recently issued report on maintenance for 1935, one may draw the conclusion that the oiled roads now being built to the state's present standards, with ample subgrade and base support, particularly at the shoulders, with the improved technique, can be maintained for $150 per mile, this figure covering all maintenance items, including a nominal figure for snow removal. High costs are almost invariably due to poor subgrade without subgrade reinforcement either in irrigation areas or on heavy bus-and-truck-traveled roads with 20-ft. mats. These sections are short and the map (Fig. 2) showing maintenance costs that is made yearly to help the engineers determine the location of the high-cost sections also is of value in determining sections to be reconstructed if the traffic warrants.

The cost of snow removal in Wyoming varies from year to year, taking 7 per cent of the total maintenance fund in 1934 and 17 per cent in 1935. Four counties, largely mountainous, Lincoln, Sublette, Teton and Uinta, have used 44 per cent of the total spent for snow removal and these counties carry but 11.8 per cent of the total traffic of the state. The large increase in total cost for snow removal, $43,000 in 1934 as against $118,000 in 1935, is due to a more insistent demand for keeping the roads open as well as the heavier snow fall last year.

Surface maintenance costs show a gradual decrease in the last four years, these being $122, $114, $108, and $96 in the order named. To surface maintenance is charged the work done on the traveled surface only, including remixing, addition of oil or gravel and patching. Higher than average costs can usually be attributed to attempts of a road to carry heavier traffic than the type can stand and indicate the need for early reconstruction. The Lincoln Highway across the southeastern end of the state averages $154 per mile, which is 50 per cent above the average but this is not considered alarming, since this 436-mi. stretch carries 30 per cent of the state's total traffic, much of it bus and truck, while it required for all maintenance only 20 per cent of the funds. It is estimated that this section earns $700 per mile in gasoline tolls from foreign vehicles while some of the less traveled roads in the system earn but $150 to $200 per mile.

With minor exceptions Wyoming has abolished the patrol system of maintenance and uses gang maintenance with large crews operating from strategic junctions. Each of the six districts is controlled by a highway engineer who handles both construction and maintenance, the latter being handled by a maintenance supervisor reporting to the engineer. There are thirty maintenance gang stations with crews covering a radius of 50 miles.

Some of the equipment stocked at the stations is as follows: 2 to 4 truck oil tanks; 1 to 4 oil distributors; 1 to 3 rollers; 10 to 15 light trucks, a large supply of tar kettles, 6 to 1½-ton pick-ups; 3 to 5 heavy trucks; 3 to 4 blade graders; 12 to 20 snow plows; 2 to 4 mowers and one ⅜-yd. shovel.

Cutback oils are used for patching. If deterioration has gone too far the entire surface is torn up, oil and gravel is added if necessary and the old and new remixed and relaid. If there is evidence by appearance of rolls that water has penetrated the subgrade or mat, both mat and foundation are torn up and allowed to dry. If the subgrade material appears unsuitable it is replaced with gravel or rock and the oil mat replaced.

Organization

The Wyoming State Highway Department staff is as follows: James B. True, superintendent-engineer; C. F. Seifried, office and plans engineer; W. H. Fisher, bridge engineer; I. E. Russell, materials engineer; J. E. Lloyd, oil engineer; and J. J. Swanson, special engineer in charge of labor relations and employment. J. G. Smith, Talcott Moore, J. R. Phillips, R. C. Kay, R. J. Templeton and George Corwine are the district engineers.

How Army Engineers Keep Costs

A review of nonmilitary work performed by the Corps of Engineers and how its cost is kept and reported

By James P. LaCroix
Head Accountant, Finance Division, Corps of Engineers, Washington, D. C.

THE CIVIL WORKS of the U. S. Engineer Department are committed to the Chief of Engineers, under direction of the Secretary of War, and they are carried on through the instrumentality of some 47 district offices located throughout the United States, Puerto Rico, and the Hawaiian Islands. These offices report through ten division offices, charged within the limits of their respective divisions, with general supervision over the execution of all public works, supervision over office methods, distribution of plant and other major items of property and general supervision of accounting methods.

Volume of work

The district offices are primarily responsible for investigations, studies, and reports on engineering projects; the design, construction, inspection, testing, operation and maintenance of engineering work; scientific research; detailed plans; specifications, and estimates of costs. They have immediate supervision over such work as stream gaging, preliminary examination, topographic, hydrographic and other surveys; studies connected with flood control, water storage and power development; the construction by hired labor and contract of engineering structures, such as levees, revetments, breakwaters, canals, locks, dams, bridges, power plants, dredging, ledge removal, removal of wrecked vessels and other obstructions to navigation; operation and care of canals, locks and dams; the construction and repair of floating plant, etc. and the operation of large repair yards and depots. They are also charged with local investigation and supervision of power structures in cooperation with the Federal Power Commission.

The cost of the above work for the fiscal year ended June 30, 1936, amounted to $229,285,045, and the number of civilian employees, exclusive of contractors' employees, during the year reached a maximum of 57,389. Table I shows, by general classes, the cost of engineer department work for the fiscal year ended June 30, 1936.

To carry on these activities under proper cost control an accurate, intelligent and workable cost accounting system is imperative. The present system is flexible and simple but was designed to furnish prompt and accurate information that would be of assistance in conducting operations in keeping with the standards of the best and latest approved practice.

Objectives of costs

The term cost as used herein is the summation of expenses expressed in terms of cash or its equivalent incurred in the construction, acquisition or maintenance of a unit or units of property. Cost accounting requires the recording of conditions, the making of measurements and the recording and analyzing of the units of labor, material, plant and other charges which enter into the cost of any given operation or into any unit of the work.

The term cost accounting should not be confused with the term bookkeeping; they are distinct in their functions and are maintained separately. Cost accounting is the process of allocating expenses as they are incurred to detail cost items of a feature of work, job, structure or other unit. Through it the various items of cost and quantities of work done are assembled in the proper groups, at the end of a given period of time, to be used for the purpose explained in the following paragraph. For cost purposes the question as to whether or not bills have been paid is of no moment. The policy of waiting until obligations are paid, in order to apply the cost thereof to the work on which it is incurred does not subserve the real purpose of cost accounting.

Cost accounting is necessary to the efficient and economical management of work, and its primary object is to show the efficiency of performance; its purpose may be defined as follows:

1. To determine whether, under existing conditions, work is being performed economically.
2. To analyze the various component feature—costs of a construction job for the purpose of determining the efficiency of labor and plant.
3. To forecast intelligently the ultimate cost of a project during the progress of the work.
4. To compare periodically the various features and elements of cost of one construction job with those of other similar construction jobs and, in case of difference, to furnish such data as will enable the engineer to discover the cause of such differences.
5. To furnish such data relative to costs, as the work progresses, as will permit an intelligent comparison with estimated costs.
6. To furnish sufficient and reliable data on completed work, for use in the preparation of estimates of the cost of future similar work.
7. To awaken a spirit of competition between the heads of different working parties on similar work.

While, as mentioned above, cost accounting and bookkeeping are distinct functions and records of costs and expenditures must be maintained separately, there is a definite relation between the two, and to be of real value costs should be entered with accuracy as they arise from time reports, bills for materials and supplies, reports of stock issues, plant rentals, etc., to the end that the aggregate cost of any job will agree with the actual expenditures therefor after necessary adjusting entries, with reference to intangible elements of costs, have been made. This reconciliation furnishes the most effective check upon the accuracy of both records.

Bidding procedure

The necessity for accurate and reliable cost data can be appreciated readily when it is considered that the general policy of the Chief of Engineers is to have all work performed by contract whenever the nature of the work and the time available for execution will permit, unless it is clearly evident, after bids have been asked, that the interest of the United States requires the work to be done by government plant and hired labor. Fig. 3 shows the total cost of engineer department work for fiscal years 1926 to and including 1936 and the amount thereof performed by contract and by hired labor (force account).

Before bids are opened the contracting officers are required to prepare

a detailed estimate of the cost of doing the work by use of hired labor and government plant. If suitable government plant is physically available, either within or without the district, to carry on the work within the limitations of time that would be allowed a contractor, or if the work can be done at a reasonable cost by plant purchased or leased for the purpose, the estimate, based on such plant, includes the following items: direct costs, including labor, materials, plant rentals including insurance; indirect costs; overhead; mobilization and demobilization; interest on capital invested at the maximum prevailing rates being paid by the United States on current issues of bonds or other evidences of indebtedness; employees liability insurance and other items properly chargeable to the work. If plant is acquired by purchase to carry on the work the depreciation charged therefor is the difference between its original cost and its salvage value or its value to the United States on completion of the work.

If no suitable government plant is available or cannot be acquired to carry on the work within the limitations of time that would be allowed a contractor, the estimate is based on the best available data as to the fair and reasonable cost of doing the work.

The character of the estimate is made known to bidders at the opening of the bids. The limitation imposed by law under Section 8 of the River and Harbor Act of March 2, 1919, prohibiting work by contract if the contract price is more than 25 per cent in excess of the estimated cost of doing the work by government plant, does not apply when no government plant is available or cannot be acquired for the execution of the work within the limitations of time established by the specifications. In the latter case a bid which exceeds by more than 25 per cent the estimated fair and reasonable cost is accepted only when it is clear that such acceptance is in the interest of the United States.

In order that the district engineer may be in a position to prepare an estimate that will, in a measure, reflect the ultimate cost of the job he must be in possession of accurate and reliable cost figures for previously executed similar work. In the event that the lowest responsible contract bid is not within the statutory 25 per cent allowable limit, or the bids are for some other reason unsatisfactory, the department rejects all bids and either readvertises the work or performs it with government plant. It is then, more than at any other time, that the value of accurate cost accounting is recognized.

General cost system

The system of control, in connection with cost accounting, as applied to the engineer department, is similar in all its activities. The decentralization of operations in the department makes it extremely important that the Chief of Engineers be furnished with prompt, accurate, digested and understandable information as to costs. This information must be dependable, available at all times and in keeping with good business practice. Cost accounting properly systema-

TABLE I—COST OF ENGINEER DEPARTMENT WORK PERFORMED BY HIRED LABOR AND BY CONTRACT FOR FISCAL YEAR ENDED JUNE 30, 1936

Consolidated

Item No.	Class of Work	(1) Hired Labor New York	(2) Hired Labor Maintenance	(3) Hired Labor Total	(4) % of Total (Col. 3+ Col. 9)	(5) Contract New York	(6) Contract Maintenance	(7) Contract Total	(8) % of Total (Col. 7+ Col. 9)	(9) Total by Items (Col. 3+Col. 7)	(10) % of Grand Total	Item No.
1	Flood Control	27,198,868.32	3,570,818.40	30,769,686.72	54.35	25,600,246.01	238,319.64	25,838,565.65	45.65	56,608,252.37	24.70	1
2	Construction of Locks and Dams	21,943,660.02	.....	21,943,660.02	26.91	59,604,528.30	.....	59,604,528.30	73.09	81,548,188.32	35.58	2
3	Operating and Care of Locks and Dams	.....	7,652,613.54	7,652,613.54	96.42	.....	284,045.20	284,045.20	3.58	7,936,658.74	3.47	3
4	Channel Work:	(3,075,963.69)	(11,557,855.82)	(14,633,819.51)	(30.66)	(30,054,958.45)	(3,039,551.98)	(33,094,510.43)	(69.34)	(47,728,329.94)	(20.82)	4
	(a) Dredging with Hopper Dredges	1,432,557.91	3,694,878.75	5,127,436.66	100.00	.....	.....	.....	.....	5,127,436.66	2.24	(a)
	(b) Dredging with other (than Hopper) Dredges, except Rock Removal	442,428.17	7,073,829.21	7,516,257.38	21.54	24,345,519.74	3,039,047.83	27,384,567.57	78.46	34,900,824.95	15.23	(b)
	(c) Dredging with other (than Hopper) Dredges, Rock Removal including Drilling and Blasting	13,700.75	.....	13,700.75	0.53	2,570,605.19	.....	2,570,605.19	99.47	2,584,305.94	1.13	(c)
	(d) Rock Removal, other than Dredging	570.78	.....	570.78	19.26	2,393.49	.....	2,393.49	80.74	2,964.27	0.00	(d)
	(e) Other Work	1,186,706.08	789,147.86	1,975,853.94	38.65	3,136,440.03	504.15	3,136,944.18	61.35	5,112,798.12	2.22	(e)
5	River Regulation:	(4,141,541.61)	(2,638,108.04)	(6,779,649.65)	(34.68)	(12,432,597.55)	(335,530.92)	(12,768,128.47)	(65.32)	(19,547,778.12)	(8.53)	5
	(a) Dikes	2,981,284.85	931,827.76	3,913,112.61	28.77	9,372,087.51	314,516.91	9,686,604.42	71.23	13,599,717.03	5.93	(a)
	(b) Revetments	868,778.97	392,091.79	1,260,870.76	31.52	2,731,520.84	8,220.48	2,739,741.32	68.48	4,000,612.08	1.75	(b)
	(c) Retards	6,514.03	.....	6,514.03	100.00	.....	.....	.....	.....	6,514.03	0.00	(c)
	(d) Dredging	179,421.39	874,411.53	1,053,832.92	100.00	.....	.....	.....	.....	1,053,832.92	0.46	(d)
	(e) Other Work	105,542.37	439,776.96	545,319.33	61.47	328,989.20	12,793.53	341,782.73	38.53	887,102.06	0.39	(e)
6	Protection Work:	(862,300.25)	(712,021.92)	(1,574,322.17)	(20.78)	(3,840,535.64)	(2,160,127.69)	(6,000,663.33)	(79.22)	(7,574,985.50)	(3.30)	6
	(a) Seawalls	.....	32,952.76	32,952.76	71.61	.....	13,067.32	13,067.32	28.39	46,020.08	0.02	(a)
	(b) Breakwaters	43,703.43	171,107.18	214,810.61	6.89	2,784,922.30	115,725.31	2,900,647.61	93.11	3,115,458.22	1.36	(b)
	(c) Jetties	13,208.50	380,051.34	393,259.93	13.57	474,181.66	2,031,335.06	2,505,516.72	86.43	2,898,776.65	1.26	(c)
	(d) Other Work	805,388.23	127,910.64	933,298.87	61.61	581,431.68	.....	581,431.68	38.39	1,514,730.55	0.66	(d)
7	Removal of Sunken Vessels	.....	9,471.93	9,471.93	6.12	.....	145,368.29	145,368.29	93.88	154,840.22	0.07	7
8	Removal of Snags and Other Obstructions	.....	893,694.42	893,694.42	99.64	.....	3,254.41	3,254.41	0.36	896,948.83	0.39	8
9	Surveys, Inspections, etc. (Not chargeable to other features of Work):	(537,440.16)	(3,058,663.21)	(3,596,103.37)	(97.98)	(16,214.32)	(57,778.51)	(73,992.83)	(2.02)	(3,670,096.20)	(1.60)	9
	(a) Examinations, Surveys and Contingencies (General)	.....	2,726,374.20	2,726,374.20	97.92	.....	57,778.51	57,778.51	2.08	2,784,152.71	1.21	(a)
	(b) Special and Miscellaneous Surveys	537,440.16	332,289.01	869,729.17	98.17	16,214.32	.....	16,214.32	1.83	885,943.49	0.39	(b)
10	Other Work	649,725.59	867,996.24	1,517,721.83	53.01	1,278,198.29	67,412.49	1,345,610.78	46.99	2,863,332.61	1.24	10
11	Administrative Expense (E. R. A.)	191,926.11	484.65	192,410.76	27.69	499,383.64	3,069.06	502,452.70	72.31	694,863.46	0.30	11
12	**Totals**	**58,601,425.75**	**30,961,728.17**	**89,563,153.92**	**39.07**	**133,326,662.20**	**6,334,458.19**	**139,661,120.39**	**60.93**	**229,224,274.31**	**100.00**	12
13	% of Hired Labor Total	65.43	34.57	100.00	.....	.....	.....	.....	.....	.....	.....	13
14	% of Contract Total	.....	.....	.....	.....	95.46	4.54	100.00	.....	.....	.....	14
15	% of Grand Total	25.56	13.51	(39.07)	.....	58.17	2.76	(60.93)	.....	.....	.....	15
16	Office of Chief Engineers (Services and Miscellaneous Expenses)	.....	.....	.....	.....	.....	.....	.....	.....	58,644.26	.....	16
17	Nicaragua Canal Survey Office	.....	.....	.....	.....	.....	.....	.....	.....	2,126.23	.....	17
18	**Total Engineer Department Cost**	.....	.....	.....	.....	.....	.....	.....	.....	**229,285,044.80**	.....	18

TABLE II—OVERHEAD BY FISCAL YEARS FROM 1931 TO 1936

Fiscal Year	Hired Labor				Contracts				Total			
	Field Cost	Overhead	% of Overhead to Field Cost	Total Cost	Field Cost	Overhead	% of Overhead to Field Cost	Total Cost	Field Cost	Overhead	% of Overhead to Field Cost	Total Cost
1931	51,296,885 03	3,898,581 24	7 6	55,195,466 27	65,741,208 58	2,820,921 20	4 3	68,562,129 78	117,038,093 61	6,719,502 44	5 7	123,757,596 05
1932	45,412,188 82	3,254,744 87	7 2	48,666,933 69	61,286,498 88	2,283,472 18	3 7	63,569,971 06	106,698,687 70	5,538,217 05	5 19	112,236,904 75
1933	47,102,037 43	3,009,664 93	6 39	50,111,702 36	64,009,085 97	2,111,299 78	3 30	66,120,385 75	111,111,123 40	5,120,964 71	4 61	116,232,088 11
1934	56,892,383 77	2,856,707 07	5 02	59,749,090 84	97,714,432 51	2,940,509 43	3 01	100,654,941 94	154,606,816 28	5,797,216 50	3 75	160,404,032 78
1935	60,197,673 55	3,191,247 12	5 30	63,388,920 67	127,572,032 52	3,385,246 28	2 65	130,957,278 80	187,769,706 07	6,576,493 40	3 50	194,346,199 47
1936	84,495,070 58	5,068,083 34	6 00	89,563,153 92	135,431,461 03	4,229,659 36	3 12	139,661,120 39	219,926,531 61	9,297,742 70	4 23	229,224,274 31
Total	345,396,239 18	21,279,028 57	6 16	366,675,267 75	551,754,719 49	17,771,108 23	3 22	569,525,827 72	897,150,958 67	39,050,136 80	4 35	936,201,095 47

TABLE III — INSURANCE AND ADJUSTMENT ACCOUNT FROM OCT. 1, 1934, TO JUNE 30, 1936

Divisions	Charges	Credits	Balance undistributed at end of fiscal year	
			Debits	Credits
A. North Atlantic	$450,702.67	$416,296.90	$34,405.77	.....
B. South Atlantic	155,138.02	84,794.30	70,343.72	.....
C. Gulf of Mexico	143,365.15	245,156.88	.....	$101,791.73
D. Great—Lakes	47,938.23	46,024.56	1,913.67	.....
E. Upper Mississippi Valley	32,006.15	194,084.68	.....	162,078.53
F. Missouri River	85,707.36	85,600.01	107.35	.....
G. Ohio River	109,577.06	329,966.56	.....	220,389.50
H. Lower Mississippi Valley	643,427.02	931,958.02	.....	288,531.00
I. North Pacific	41,828.14	30,981.72	10,846.42	.....
J. South Pacific	15,886.62	213,525.53	.....	197,638.91
Totals	1,725,576.42	2,578,389.16	117,616.93	970,429.67
Net balance				852,812.74

tized is the soul of efficient control in the management of engineering operations. There must be no variance in system by the various district offices. To guard against this and to secure absolute uniformity, each division engineer is assigned a division accountant, whose duty is to make periodical inspections of each district and check, instruct and assist the accountants in local charge of the cost work. The head accountant in the office of the Chief of Engineers is responsible for the compilation of cost statistics and for the general accounting results throughout the department. He makes periodical inspections of the records in each district and confers with accountants and district and division engineers on matters pertaining to accounting. A cost accounting manual, approved by the Secretary of War, Feb. 16, 1927, and revised Sept. 15, 1931, covers the general scheme in effect and compliance therewith is mandatory. The following is a brief general description of the operation of the system:

Labor Charges—All labor costs are compiled from either a daily labor report or from the 15-day time roll depending on the character of the work involved. If the work consists of various subitems such as would ordinarily be set up for the construction of a lock and dam, or similar work, labor distribution is reported daily. If the work is of such character that few subdivisions of costs are desired, such as dredging a channel, labor charges are reported at the end of each 15-day period.

Materials and Supplies—The purchase of materials and supplies is merely a conversion of cash into another form of asset equally as valuable and proper accounting for such items requires almost the same degree of thoroughness as is required in the handling of actual cash; therefore, adequate facilities are provided for handling, storing and care of these items. All such items purchased are initially charged to a stock-control account, unless such items are delivered direct to some unit of plant, the location of which would make it impracticable to receive such deliveries at the storehouse and reissue, or where items are delivered direct to some job for immediate use. The stock-control account is debited with all receipts and credited with all issues (requisition on storekeeper). The balance in this account represents the amount of stocks on hand at any stated date. The requisitions on storekeeper are summarized daily, or at less frequent intervals if the number of issues does not justify the preparation of the daily summary, and each job to which issues have been made is charged with the appropriate amount as shown thereon.

Plant Charges—Plant-operation accounts are maintained for all major items of plant, and all operating costs such as payrolls, subsistence, fuel, lubricants, plant rental, etc. are posted currently to these accounts. At the end of each month the net operation cost for each item of plant is prorated on a time basis to the job or jobs on which the plant was engaged during such period.

Overhead—The term overhead as used by the engineer department means all administrative and supervision costs which cannot be charged direct to a specific job. It includes all such costs in the district and division offices as well as the office of the chief of engineers.

A control account is maintained in each district office to which all such expense is debited. Appropriate credits are made to this account each month and the amounts thus credited are charged as overhead to the various jobs on which work was done. Due to the fact that the overhead costs remain somewhat constant throughout the year and do not fluctuate with the seasons during which construction work can be performed, the credits to this account are charged to the jobs on a predetermined percentage basis. This account is frequently analyzed and great care is exercised to see that the balances are charged out during the fiscal year, unless it is definitely determined that certain portions of the overhead charges accrued as a result of the anticipated work of the ensuing year, in which event the distribution of such charges is deferred.

It is not considered equitable to charge the same proportion of overhead to work performed by contract as is charged to work performed by hired labor and government plant. Therefore, each class of work is charged with that portion of overhead which represents the approximate percentage of administrative effort expended on such work. It has been determined that this effort is applied approximately in the proportion of 1:2, that is, only one-half the percentage of overhead charged to work performed by hired labor and government plant is charged to the work done by contract unless in certain instances it is determined by actual test that the proportion should be otherwise. Table II shows the cost of work performed by the department during fiscal years 1931-1936 and the amount of overhead included in such costs.

Plant cost accounting

All engineer department plant and equipment, except that which belongs to the national-industrial-recovery, public-works and emergency-relief projects, is owned, operated and maintained by a special plant project, hereafter referred to as the plant allotment, under the appropriation for which the plant is primarily used. The Secretary of War, under date of Dec. 13, 1934, approved the establishment of the plant allotment

ANNUAL CHARGES TO PLANT RENTAL ACCOUNT							EARNED RENTAL		
YEAR	DEPRECIATION	REPAIRS	CESSATION OF WORK	SMALL TOOLS, ETC.	TOTAL	AVERAGE PER DAY	DAYS	RATE	AMOUNT
DISTRICT			ITEM OF PLANT			CLASS OF PLANT			

FIG. 1—FORM FOR summarizing actual annual debits and credits to the plant rental account

PLANT RENTAL COMPUTATION		
1	SUBMITTED AS OF	6/30/36
2	YEAR & MONTH BUILT OR ACQUIRED	JUNE, 1935
3	ESTIMATED LIFE-YEARS	40
4	ORIGINAL COST	404,000.00
5	ADDITIONS AND BETTERMENTS	
6	TOTAL COST	404,000.00
7	DEPRECIATION CREDITED	105,600.00
8	REMAINING BOOK VALUE	298,400.00
9	ESTIMATED SALVAGE VALUE	20,000.00
10	BALANCE TO BE DEPRECIATED	278,400.00
11	ESTIMATED REMAINING LIFE-YEARS	29
	ESTIMATED ANNUAL CHARGES:	
12	DEPRECIATION	9,600.00
13	REPAIRS & REPLACEMENTS	51,000.00
14	CESSATION OF WORK	1,000.00
15	SMALL TOOLS, ETC.	1,400.00
16	DEBIT OR EXCESSIVE CREDIT BALANCE IN PR. ACCOUNT ABSORBED	
17	TOTAL ANNUAL RENTAL	63,000.00
18	ESTIMATED AVERAGE DAYS IN USE	300
19	DAILY RENTAL RATE	210.00
20	APPROVED BY CHIEF OF ENGINEERS	

FIG. 2—DEPRECIATION FORM used to list charges on which per diem plant rentals are based. The item of plant in this example is a floating dredge.

as of Oct. 1, 1934. To put this plan into effect it was necessary to set up a revolving fund in each district, from which all initial expenditures for purchase, operation and maintenance of plant are made and as the plant works on various projects these projects reimburse the plant allotment for such expenditures. This procedure has greatly facilitated accounting and simplified the maintenance and operation of the plant. The following plant accounts are maintained in the district offices for each major item of plant and for groups of similar minor items: plant cost (capital account), plant rental and plant operation.

Plant Cost Account—This account is intended for use in assembling the cost data covering any item or class of plant and for maintaining a perpetual record to show the remaining book value of plant. The first debit entry to this account is the actual cost of the item of plant. Other debit entries are made as additions and betterments are added to the plant. At the end of each month this account is credited with the monthly proportion of the predetermined annual depreciation, which amount is at the same time debited to the appropriate plant rental account. The balance in this account at the end of the month represents the remaining book value of the time of plant. Periodic checks are made of the remaining book value of plant for the purpose of determining the sufficiency of the depreciation charge and corrections are made when such action is considered appropriate. When plant has increased in value due to the application of extensive improvements and additions, the rate of depreciation is promptly corrected.

Plant Rental Account—For cost accounting purposes the work upon which the plant is engaged is charged only with that portion of plant cost actually expended on the work. Actual expenditures of plant cost, expressed as plant rental, represent that portion of plant service actually consumed on the work. The cost of the service of plant can most readily be charged to the work upon which engaged in the form of a per diem rental. The per diem rentals are made up of charges for *depreciation, repairs* and *replacements, cessation of work* and *small tools.* (Cessation of work charges are the expenses necessary for taking care of the plant during the nonworking season). The costs of these items are debited to this account. The credit to this account is the amount of earned rental which is posted at the end of each month. This account is so maintained that ultimately the total amount credited will about equal the aggregate amount charged. Normally the balance in this account is on the credit side. Any temporary balances are treated as deferred items for subsequent adjustment.

Plant Operation Account—This account was designed for the purpose of uniformly recording all appropriate costs in connection with the operation of certain classes of plant. For example, the cost of the following items is posted under appropriate headings to this account for each major unit of floating plant: (1) payrolls, (2) subsistence, (3) fuel, (4) water, (5) miscellaneous supplies, (6) lubricants, (7) plant rental, (8) attendant plant (cost of operation), (9) miscellaneous expenses and (10) insurance. At the end of each month the net total operating costs for the period is charged to the job or jobs which the plant was engaged, as has already been explained above.

Depreciation rates on plant as applied by the engineer department are obtained by use of the straight-line method. By it the annual rate to be charged to the plant rental account is obtained by dividing the initial cost of the plant plus additions and betterments, if any, minus a normal amount for salvage value, by the number of years which are estimated to form the economic life

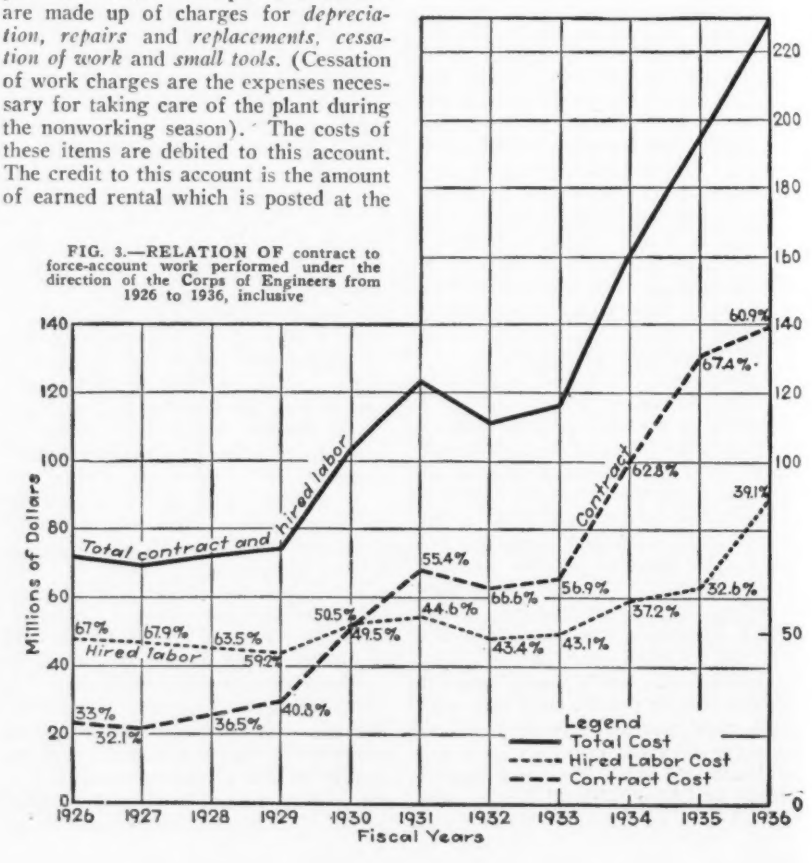


FIG. 3.—RELATION OF contract to force-account work performed under the direction of the Corps of Engineers from 1926 to 1936, inclusive

of the plant. In determining the economic life of plant, consideration is given to the expected operating conditions, character of work and such other factors as will affect the durability of the plant. Great care is exercised to see that the rate adopted will not make it possible ultimately to charge to the cost of the work, in the form of depreciation, a greater sum than its pro-rata share of the amount actually expended for the plant used. Depreciation in the value of plant commences from the moment of purchase or the completion of its construction, and occurs as a result of wear and tear due to active use and physical deterioration and decay during a period of idleness. These forms of depreciation are termed natural depreciation. Another form of depreciation is termed functional depreciation, and is a loss due to the fact that plant of more modern design and of greater efficiency has been developed that makes it desirable to abandon or remodel the old unit in order that work may be prosecuted with greater speed and efficiency by use of the more and improved equipment. The losses in value as explained above necessarily become operating losses that must be absorbed by the work upon which the plant is employed as a par of the cost of such work based upon the time the plant is employed thereon.

All per diem plant rentals are computed by the district office and are submitted through the division engineer concerned to the chief of engineers for approval. A complete file of all approved rentals is maintained in the office of the Chief of Engineers. Form No. 22, Fig. 2, illustrates the application of the above-mentioned depreciation charges on which per-diem rentals are based.

Form No. 22-A, Fig. 1, is used for summarizing the actual annual debits and credits to the plant rental accounts. The data shown on this form are used by the districts in the revision of per-diem rental and in the preparation of estimates for rentals on similar new plant. When plant is worn out in service or otherwise disposed of a copy of this form with appropriate data shown thereon is submitted to the Chief of Engineers and is used in the compilation of pertinent statistical plant data.

An insurance account was established as of Jan. 1, 1935, and is maintained under the plant allotment in each district. The purpose of the account is to charge into the current costs of all work performed by engineer department plant an amount which from experience reflects those charges due to loss of property or value which have heretofore been charged to completed work as they accrued, and which were not reflected in the detailed unit costs of such work. The basis for absorbing the losses charged to the insurance account is the earned plant rental on plant used. Two per cent of the earned plant rental each month is charged to the plant operation account which in turn is prorated along with other plant operation costs to the work on which the plant was engaged. The per cent charge is subject to revision by the Chief of Engineers and such increases or decreases, if any, in the percentage as may be necessary to absorb the losses are made as and when the records indicate such revision is necessary. This account is debited with all losses and is credited with 2 per cent of the earned plant rental. The credit balance in this account represents the reserve to be used along with subsequent credits to the account to absorb future losses. Table III shows the status of this account by divisions and for the department as a whole as of June 30, 1936.

All accounts are maintained in the district offices in ample detail to permit of any logical analysis and the information shown therein is used by the district engineers in the administration of the affairs of the district and for the preparation of monthly, annual and special reports submitted to the division engineers and the Chief of Engineers. The reports show quantities, costs, and unit costs under appropriate heading this period, to date, and estimated total, for each feature of work (a feature of work being a subdivision of a project) under a project, and serve to keep the Chief of Engineers currently informed as to the progress and cost of the varied operations for which he is responsible.

In summary, a cost accounting system is in operation on civil works under the control of the Chief of Engineers, War Department, that is simple in its application, sufficiently comprehensive in its scope to reflect costs accurately, and so flexible in its set-up as to be readily adaptable to a wide variety of projects involving the expenditure of public monies, the safeguarding of which, in the final analysis should be the primary consideration for all concerned.

Cast Iron Pipe with Flexible Joints Used for Stream Crossing

Special flexible joints aid installation of water pipeline beneath a navigation canal at New Orleans

By Alexander Allison, Jr.,
Designing Engineer, Sewerage and Water Board, New Orleans, La.

FLEXIBLE JOINT water main stream crossings are not unique, but certain features of the crossing of a 12-in. water main under the inner harbor navigation canal at New Orleans, which connects the Mississippi River with Lake Pontchartrain, are unusual and interesting. In the first place, special requirements imposed by agencies controlling the property over which the line was laid fixed its route rather definitely. Also, a special flexible joint cast iron pipe was utilized successfully for the stream crossing portion of the line.

The water main is being laid by the sewerage and water board of New Orleans along the Chef Menteur highway. The canal to be crossed is 300 ft. wide at the top with a bottom width of 175 ft. and a depth of 30 ft. below mean low lake level and is situated in the center of a strip of ground 2000 ft. wide, both the canal and the adjacent property being owned by the New Orleans dock board. Levees along both sides of the canal are controlled by the board of levee commissioners. The highway and the bridge crossing the canal are under the jurisdiction of the Louisiana highway commission. All of these agencies, except the sewerage and water board, are controlled by the state.

Plans for future development of the banks of the canal by the dock board made it undesirable for a water pipe to be placed anywhere except close to the highway. The dock board also required that the top of the water pipe should be at least 10 ft. below the bottom of the canal for the full width. This latter requirement made the excavation for the pipe so deep that the highway commission would not permit the crossing to be closer to the bridge than the end of the bridge fenders. The requirements of the levee board involved restoration of the levees and the placing of concrete bulkheads around the pipe.

These several requirements practically drew the plan for the crossing: the pipe, with about 3 to 4 ft. of cover, must approach the canal along the highway; at the water's edge it must turn sharply away from the highway and down into the canal. At the bottom it must resume the horizontal running parallel with the highway; and on the far side it must reverse these directions coming back to a trench along the highway.

The certainty of considerable joint deflection in a line following the prescribed route made some sort of flexible joint necessary. The special type of joint adopted is shown in Fig. 3. It is manufactured as an integral part

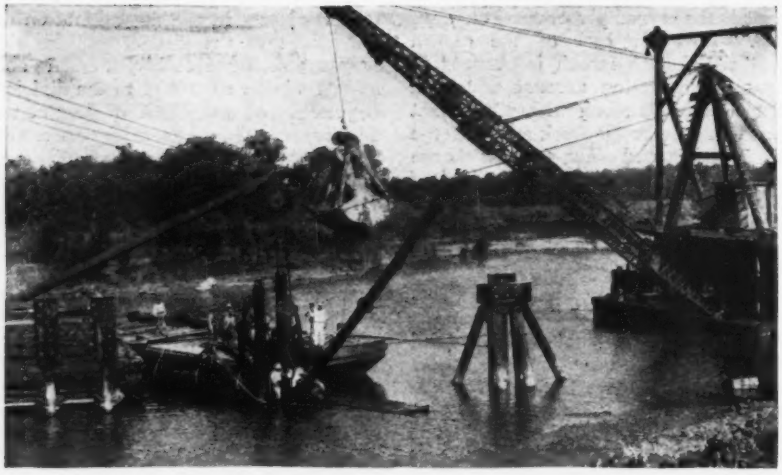
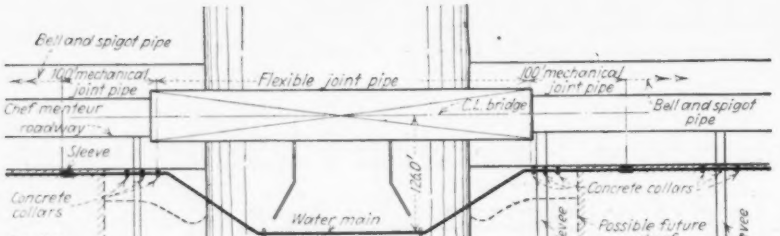


FIG. 1—CONNECTING bank section of pipe to horizontal run before lowering line to bottom of canal.



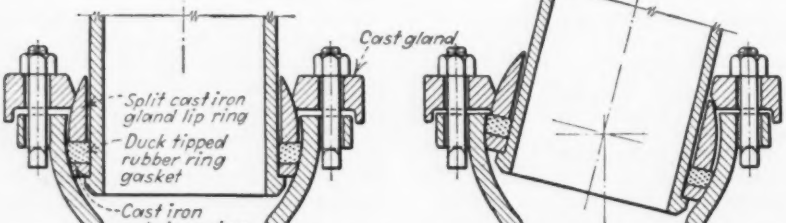
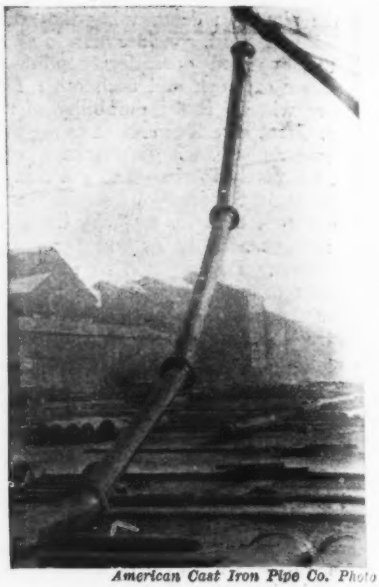


FIG. 2—LAYOUT of pipe line crossing of New Orleans industrial canal. Curve in alignment was necessary to keep deep trench excavation at safe distance from bridge piers.

FIG. 3—MAKEUP of flexible joint used on cast iron pipe crossing of New Orleans industrial canal.

of 16 ft. pipe lengths with a spherical socket on one end and with a square bead cast on the opposite or spigot end. A cast iron retainer ring is stretched over the bead on the spigot, to form a seat for a duck-tipped rubber gasket. Next to this a split gland lip is assembled around the spigot. The outer



American Cast Iron Pipe Co. Photo

FIG. 4—JOINTS DEFLECTED in test of line before shipment of pipe to the job

surfaces of the ring, the gasket and the gland are given a spherical form corresponding to the spherical inside surface of the pipe; they, in effect, constitute the spherical ball. The spherical socket cast on the bell end of the pipe is large enough to receive this composite ball, which is held in place by a bolted flange, the interior surface of which is so shaped as to extend and complete the spherical socket. The joint allows an angular deflection of 15 deg. from the straight line in any direction.

In the canal crossing thirty-one 16-ft. lengths of this flexible joint pipe with four one-eighth bends, also equipped with ball and socket joints, were used. The pipes were delivered with the joints fully assembled, requiring only removal of the protective wrappings, insertion of the ball in the socket and bolting up.

A dredge with clamshell bucket proved unable to complete the deep excavation and a suction dredge was called into service. Two pairs of 75-ft. creosoted guide piles were driven to keep the horizontal line of pipe in place after the trench was ready for the pipe. Two barges were lashed together end to end, and eleven 16 ft. lengths of pipe were put together on the barges, the joints made up and the long line of pipe lowered over the side and held just above the waterline. The barges were then towed into place and the two ends of the pipeline inserted between their respective guide piles. One length of pipe and a bend were then assembled, lowered into place and connected to the horizontal line. This end of the horizontal line was then lowered into the water until the diagonal pipe was partly submerged; the diagonal pipe was secured to a pontoon, and activities

were transferred to the other end.

Two joints and a bend were added at the opposite end, after which the whole line was lowered further. Additional joints were placed at each end two at a time and the line lowered after each addition until the whole pipeline rested on the bottom of the trench. The one-eighth bends were then attached to the shore ends, followed by six lengths of pipe connected by mechanical joints. Concrete bulkheads, extending 2 ft. on each side of the pipe were built, after which the underwater trenches near the shore were backfilled and the deep trench was partly filled.

The contractor on the work was J. B. McCrary Co., Inc., Atlanta, Ga. The supervising engineer for the sewerage and water board was H. B. Myers, Jr. The pipe is manufactured by the American Cast Iron Pipe Co.

Scattered Construction Operations Connected By Radio Telephone

Radio telephone communication between headquarters of the Passamaquoddy power project and operations on drill boats and islands demonstrates practicability and cheapness of the system

By Royal B. Lord
Captain, Corps of Engineers, U. S. Army, Eastport, Me.

COMMUNICATIONS on large construction jobs where operations are carried on over an extensive area present a problem that is not always readily solved by a telephone or telegraph installation. Where the work is carried on in an isolated area or on water, the installation of wire communication will be expensive and, in most cases, prohibitively so because of the natural obstacles encountered.

At Eastport, Maine, during the preliminary construction operations for the Passamaquoddy Bay tidal power development this problem was solved by the installation of a communication system using the radio telephone. The accompanying map shows the location of the various features of the project.

At *A*, underwater boring investigations were required in the deep water channel between Eastport and Lubec. This work was extremely hazardous and in many cases rough water prevented physical contact by small boats. Constant communication was necessary from the drill boats to shore and vice versa to provide weather reports and for the service of the job which frequently required mechanical facilities urgently.

On Treat Island, point *B*, construction was under way on the Treat-Dudley Island dam, the navigation lock, the filling-gate structure and other construction facilities, such as docks and roads. As work was conducted on a 24-hr. basis using heavy construction equipment, a positive communication system was required in this isolated locality for efficient operation.

Carlow Island, point *C*, was the hub of the construction for three rock and earthfill dams. Although this location was accessible by railroad trestle, no wire service was available. As the three dams were being constructed by use of railroad haul, the item of train dispatching presenting a problem that required infallible communication, to prevent lost time. The key to the operations was the maintenance of a proper train schedule for the work trains, which schedule was required to be coordinated with that of the regular main line trains having priority. Operations were directed from point *D*.

FIG. 1—WIDELY SCATTERED OPERATIONS on the Passamaquoddy power project were kept in communication with headquarters in Quoddy Village by radio telephone.

It was estimated that the deep-water investigations would require four months; the Treat Island work three years and the dams at Carlow Island six months. Communication would then be required progressively at other isolated localities as other major features of the project were undertaken. The construction of the large earth-blanketed rockfill dams between Moose Island and Treat Island and between Dudley Island and Lubec were long-time jobs. The opening up of quarries for material for these dams and for crushed rock to be used as aggregate for concrete would occur simultaneously with the construction of the dams.

A communication system to meet the above conditions was immediately necessary at the start of operations. The basic requirements which governed in the selection were: An efficient fool-proof system and one that would be economical to install and operate. A wire service would require an expensive installation as no lines existed at or near the localities. Also by this method no communications could be provided for the marine work during deep-water investigations or during the construction of the large dams. Wireless telegraphy, although acceptable, would meet the first condition but would not prove economical due to the restrictions which require trained operators and the necessity for their continuous employment in order to operate the stations. Radio telephone, on the other hand, met all conditions indicated above and was found to be the most economical, even when the initial cost was liquidated over a short period of time.

A distinct advantage of this unit is its simplicity and ease of operation. No special operators are required and no code is necessary to be transcribed—a weakness in wireless telegraphy which would permit error in sending and receiving messages. The radio telephone can be used with equal facility to the direct-wire telephone. At all times messages are clear and understandable if the operating range does not exceed 30 miles. Important messages can be communicated to the field without having a third party to act as the operator.

Radio telephone stations were located in the administration building at operations headquarters, at Carlow Island, at Treat Island and aboard the floating plant from which borings were taken. An operator-mechanic was on constant duty on the key set in the administration building. He was in charge of the system and made inspections at the other stations, to service the sets when necessary. During his absence an office employee acted as operator in the administration building. In the field stations no operator was required and messages were sent by designated individuals of the field office force who performed this service in addition to their normal duties. As all sets were equipped with loud speaker attachments, units could operate on a call system and constant attendance at the field office was not essential.

Radio Telephone—The total installed cost of four radio telephone sets was

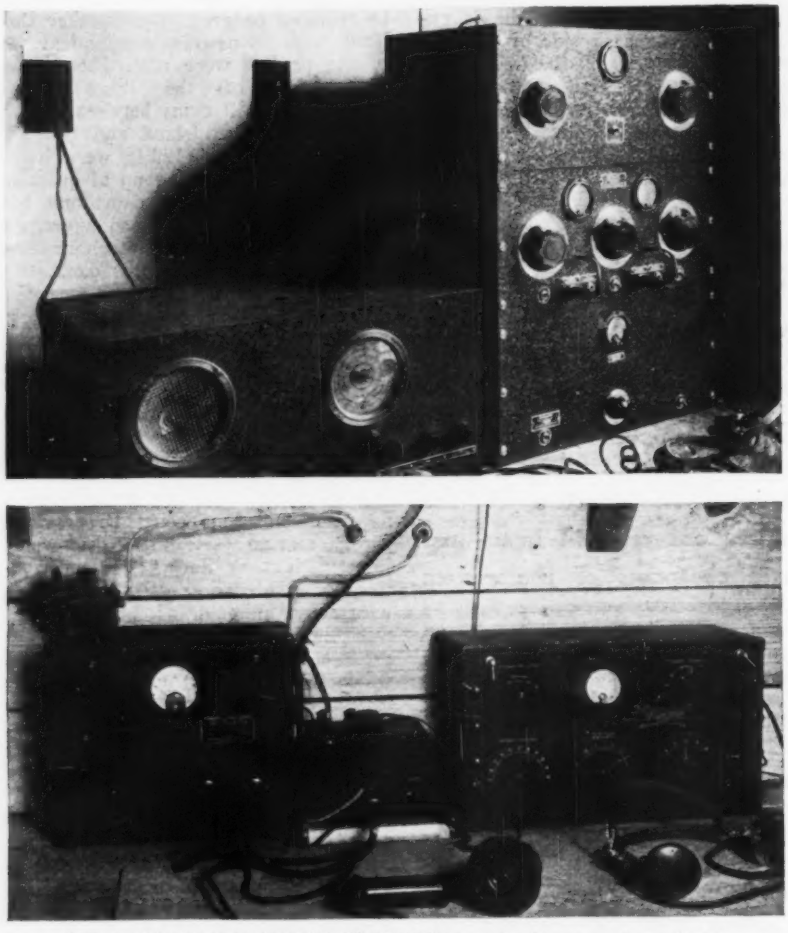


FIG. 2—RADIO TELEPHONE EQUIPMENT on the Quoddy project. At the top, equipment at headquarters where an outside supply of power was available, and, below, equipment used in one of the isolated field offices.

$1,186 or about $296 for each complete unit in operating condition.

Operation and message cost based on a six months period were as follows:

Total maintenance and power	$128
Mechanic-operator	800
Total operating	$928
Total messages sent and received in the period	13,500
Operation cost per message	$.0686
Total cost per message to liquidate the investment in 3 years	$.0854

Wireless Telegraphy—It was estimated that if a system of wireless telegraphy was installed, the initial cost of four stations would be $936, plus two-shift operating cost for six months of $6000.

The total cost per message, liquidating this system over a three-year period, would be $0.465.

Direct-Wire Telephone—The estimated cost for initial installation of a direct-wire telephone system was $7,626. The total cost per message, liquidating this system over a three-year period, would be $0.65. This installation would not provide a complete communication system and regardless of cost could not be considered.

The equipment used in the field, where 110-volt 60-cycle power was not available, was of a U. S. Army Signal Corps design; this equipment was designed originally for use on a frequency of 940 kilocycles, but due to the fact that this frequency was not authorized for this work, the circuits were altered for use with a frequency of 1,584 kilocycles. The transmitters contain three tubes, one as an oscillator amplified by an untuned stage of radio frequency. Speech modulation was accomplished by a single-button carbon microphone transformer coupled to the modulator tube. Modulation of the carrier wave was accomplished by connecting the plates of both radio frequencies and modulator tubes as in a Heising circuit.

The battery receiver was a four-tube regenerative circuit consisting of one-tuned radio frequency, a regenerative detector and a two-stage audio amplifier. The Western Electric tubes had a filament voltage of 4 and a plate voltage of 40. The filament power was supplied from storage batteries, and plate power was supplied by two 20-volt B batteries. The output was regularly used on phones or loud speakers.

The control box was used for switching from the sending to the receiving operation and vice versa. This also controlled a 12-and 350-volt dynamotor supplying power to the transmitter from 12-volt storage batteries.

Antenna equipment was of the Marconi type 148-ft. in length and used with a ground connection. The range limitation of this set is 30 miles.

Equipment used at operations headquarters, the central station, where 110-volt 60-cycle power was available, consisted of a 30-watt transmitter, employing five tubes for radio frequency, and six for modulation. Power for plate circuits was supplied from full-wave mercury vapor type 83 rectifiers.

The radio frequency circuit was controlled by a crystal ground to a frequency of 1584 kilocycles exciting a type 56 tube in conjunction with a type 53 tube as a buffer. The buffer circuit was capacity coupled to the type 46 tubes operating in parallel.

The modulator consisted of six tubes, one type 57 tube, one type 56 tube and three type 46 tubes, receiving plate supply from a full-wave rectifier tube type 83.

With this unit an Astatic microphone model D-104 was used directly coupled to a control grid of the type 57 tube, which was used as a speech amplifier, which in turn was capacity coupled to a type 56 audio amplifier tube, thence the transformer was coupled to a pair of type 46 tubes operating in push-pull. Modulation of the carrier wave was accomplished by connecting the two plates of the type 46 tubes of the modulator to the plate circuit of two type 46 tubes in the R. F. unit. The modulation unit had a gain of about 110 decibels with an output of 30 watts and 100 per cent modulation. A control switch was so connected that in switching from transmitter to receiver or vice versa the high voltage was always open in the unit not in use. The antenna used with the a.c. equipment was similar to that used with the d.c. apparatus as previously described.

The R. C. A. 136 receiver was a seven-tube, three-band, a.c. superhetrodyn with a range from 540 to 1,800 kilocycles utilizing an intermediate frequency of 460 kilocycles power consumption of 85 watts.

The a.c. installations gave very satisfactory service over long distance, as two way communication was established between Eastport, Maine and Portland, Maine, a distance of about 200 miles.

The above sets, although of U. S. Army design, can be procured from any manufacturer of radio equipment.

Field investigations for the Passamaquoddy project and the initial construction work was done by the Corps of Engineers with Lt. Col. Philip B. Fleming as district engineer in charge. Work on the project was stopped last summer. For a description of the project see *ENR*, Apr. 23, 1936, p. 583.

Federal Aid For Stream Pollution

An interpretation of the Barkley-Hollister-Vinson Act sponsored in the Ohio Valley which proposes a federal-aid program of pollution abatement in which cooperative state activity would be supplemented with the technical assistance of the U. S. Public Health Service

IN THE OHIO RIVER VALLEY, *one of the most highly industrialized regions of this country, the problem of stream pollution is vital to more than 17,000,000 people. For many years various groups have sought corrective measures but lack of concentrated support and the complexities of action involving interstate interests greatly hindered progress. In 1934, stimulated attention to the problem led to an amalgamation of diversified group-interests, and in June, 1935 the Cincinnati Chamber of Commerce established a working organization of 50 men to comprise an active committee on stream pollution. The activities and accomplishments of this committee are outlined in a recent report by Hudson Biery, chairman, from which the following extract has been made.* —EDITOR.

HOLDING that streams of the Ohio valley were not intended to serve as sewers and that they should be restored to their proper use in the fields of health, conservation, commerce and recreation, the Committee on Stream Pollution of the Cincinnati Chamber of Commerce, appointed in June 1935, adopted the following platform: (1) That it would promote legislation to control pollution of these streams; (2) encourage the construction of disposal plants; (3) conduct a general program of education; and (4) coordinate as far as possible all local efforts to accomplish these ends. Various subcommittees were appointed, one on research and planning, another on legislation, another on federal policies, and another on sanitation surveys.

The committee on legislation, after completing an intensive amount of research and investigation into existing and proposed legislation, concluded that a new start was necessary and that common ground should be found on which practically all elements favorable to stream purification could be brought together.

Early legislative steps

Two schools of thought became apparent at an early date, one that the stream purification program should be guided by the U. S. Engineer Corps, and the other that it should be directed by the U. S. Public Health Service. Without attempting to determine the particular federal agency that should have the responsibility, the Ohio valley organization developed bills of both types, which were duly presented in Congress by Senator Barkley of Kentucky and Representative Hollister of Cincinnati. A third bill from the same authorship sought the right for states in the Ohio valley to enter into a compact or treaty which would lead to the abatement of stream pollution. The latter bill, which became an amendment to a similar bill covering a treaty among states in the Connecticut River valley, was passed by the House and Senate and signed by the President. Ohio valley states are now moving toward the accomplishment of that treaty.

Shortly before hearings were conducted by the Rivers and Harbors Committee of the House, and the Commerce Committee of the Senate, a new bill was presented by Senator Barkley, also one by Representative Vinson of Ashland, Ky., incorporating the principal features of the original Barkley-Hollister legislation, but also including provision for loans and grants-in-aid and certain other features taken from other pending bills on the same subject.

These various changes advanced the legislation several steps farther than was contemplated originally by the Ohio valley group, but were largely acceptable and promptly supported in the hearings that followed.

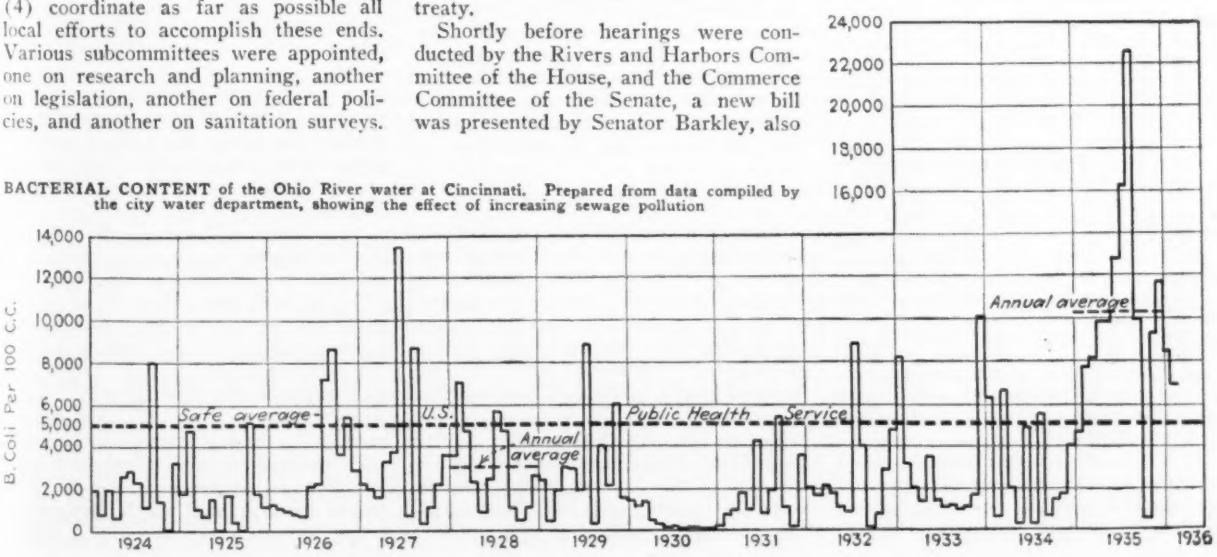
The proposed bill

In Communication No. 25, issued on Oct. 21, 1936 by the Cincinnati Committee on Stream Pollution, Hudson Biery, chairman, the provisions of the Barkley-Hollister-Vinson stream pollution legislation are summarized as follows:

1. It establishes a division of water pollution control in the U. S. Public Health Service. This would not be a new activity of the Public Health Service, but an extension and elaboration of functions administered snice 1914, principally through its stream pollution investigation stations. The Public Health Service, started in 1798, is one of the non-political career services of the government and is supervised by a corps of commissioned officers which insures continuity of policy, programs, and administration.

2. It provides for joint investigation and for the preparation, in cooperation

BACTERIAL CONTENT of the Ohio River water at Cincinnati. Prepared from data compiled by the city water department, showing the effect of increasing sewage pollution



with the state agencies, of a comprehensive plan for eliminating or reducing pollution of the waters of the United States, with due consideration to their use as public water supplies, propagation of fish and aquatic life, recreational purposes, agricultural, industrial, and other legitimate uses.

3. It authorizes the Public Health Service, upon the request of the state health authorities, to make investigations and surveys of any specific problem of stream pollution confronting any state, drainage basin authority, community, or municipality, and to make definite recommendations for the elimination or correction of unsatisfactory conditions.

4. It provides for the encouragement of cooperative activities by the several states for the prevention and abatement of pollution; encouragement of the enactment of uniform state water pollution laws; and the encouragement of compacts between the several states for the prevention and abatement of water pollution.

5. It provides for the publication by the Public Health Service of reports of studies, investigations and surveys, together with appropriate recommendations for the control of pollution of the waters of the United States.

6. It provides for federal aid in the form of grants-in-aid and loans for the construction of remedial treatment works for any state, municipality or other public body which is discharging sewage or waste into public waters. The plans must be approved by the state health department and by the public health service, and the federal financial aid shall be granted only upon their respective request and approval. Grants and aid are limited to 33⅓ per cent of the cost of labor and material, including the cost of preparation and execution of plans, in this legislation as previously passed by the House of Representatives.

7. It provides for federal aid in the form of loans for the construction of remedial treatment works to any private corporation discharging untreated or inadequately treated sewage or deleterious waste into public waters. Loans are made only upon the recommendation of the state health department and upon approval of the Public Health Service and after the plans have been approved by both.

8. It provides for the annual preparation by the Surgeon-General of the Public Health Service of an estimate of the funds required each year for loans and grants and aids for remedial construction work and the transmission of the estimate to Congress by the President with recommendations; and the authorization of the appropriation of funds annually by Congress for these purposes.

9. It authorizes an initial annual appropriation of $300,000 per year for carrying out of these activities by the Public Health Service (exclusive of funds appropriated as explained in item 8) and the allotment of $700,000 annually for a ten year period to the State Department for expenditures in promotion, investigation, surveys and studies necessary in the prevention and control of stream pollution under the supervision of the Public Health Service in accordance with rules and regulations prescribed by the Secretary of the Treasury, which presumably will require the states to provide similar funds from their own revenues.

It should be apparent from this brief summary of the terms of the proposed Barkley-Hollister-Vinson act, states Hudson Biery, that it provides two elements necessary for constructive work in stream pollution control: (1) strengthening of the state organization so as to be able to respond to public demand for adequate force in the state laws and regulations, and (2) the availability of federal funds for loans and grants to states and municipalities and loans to industry for stream pollution abatement.

Public reaction

In the hearings on the legislation there was neither radical support nor violent opposition to the bill. Both proponents and opponents were in agreement that federal legislation along lines of technical guidance and financial stimulation was necessary for the effective promotion of water pollution control in the United States. All parties were agreed that there should be no federal encroachment on the rights of the 48 states in these matters.

According to the report, the legislation is not regarded as perfect, but it is rapidly developing into a practical program. When the bills are again presented in January, the committee believes that there should be included a few provisions that are desirable in the light of sound budgetary policy. This refers particularly to three sections of the Vinson bill which would permit any project which had the approval of the proper state board of health and the surgeon general to be eligible for Treasury money, either to the extent of a 33⅓ grant for a public project, or for a loan for a private project. Under these sections of the bill as it was last presented, there is no limitation to the amount for which the Treasury might be called on. There is no provision for placing the more important projects first, since money is limited. Granting such general power may be of doubtful constitutionality, it is felt that this work should be carried on very much in the way rivers and harbors work is administered, namely, that examinations and surveys should first be made and then after a report to Congress, there should be a bill passed stating the specific projects which should go forward, such a bill to carry the necessary authorization and, of course, to be later followed by a proper appropriation.

Federal and state rights

The Barkley-Hollister-Vinson bill, states the report, will leave intact state control of water pollution. In each of the states there is a state health department. In the 34 most populous states there are laws vesting these departments with responsibility in varying degree for the control of water pollution.

Recognition by the Supreme Court in decisions of the principle of equitable division of the use of water and of domestic water supply as the highest use of water, emphasizes the wisdom of supporting effective stream pollution control by these state health agencies vested with state responsibility in water supply matters. There is no constitutional authority for federal water pollution control, on any other basis than cooperation with states through their established health agencies. Any federal legislation which fails to recognize this fact will not succeed, both because of its unconstitutionality and opposition by the states. The proposed Barkley-Hollister-Vinson legislation is stated to be in complete accord with the principle of state supremacy in this field where the government of the United States, being a government of delegated power, receives no grant or power in the Constitution, either expressly granted or reasonably implied, according to best authority. The government has a limited jurisdiction over navigable waters of the country, but beyond that limit it has no authority. Failure to recognize the extent of power in this regard has caused confusion to develop wherever federal control of stream pollution is discussed.

The federal government was, by Art. 1, Sec. 8, Clause 3, of the Constitution, given the power to regulate commerce with foreign nations and among the several states. Such grants necessarily carried with it the power of control over navigable waters of the country to that extent necessary to effectually exercise the expressed authority contained in that clause. A small degree of control is also derived from the grant to the United States of judicial power in cases of admiralty in maritime jurisdiction contained in Art. 3, Sec. 2, Clause 1.

The authority of the United States over waters has been legally defined as follows: "By virtue of the commerce clause of the federal constitution and the clause empowering Congress to make all laws necessary to carry into execution the federal judicial power in admiralty in maritime matters, 'navigable waters of the United States', which include waters over which by themselves or in connection with other waters commerce may be carried on between states or with foreign countries, and of which admiralty has jurisdiction, are under the control of Congress which has power to legislate in regard thereto so far as commerce is concerned."

The Supreme Court in the case of *Port of Seattle* vs. *Oregon-Washington Railroad and Navigation Co.*, held that "The right of the United States in the navigable waters within the several states is limited to the control thereof for purposes of navigation," and in the case of *Escanaba and Lake Michigan Transportation Co.* vs. *the city of Chicago*, "The powers vested in the general government to regulate interstate and foreign commerce involve the control of the waters of the United States which are navigable in fact, so far as

it may be necessary to insure their free navigation, when by themselves or their connection with other waters they form a continuous channel for commerce among the states or within foreign countries."

It seems clear, states the report, that unless any control sought by the federal government over the waters of the country is necessary to the maintenance of free navigation, it will have no constitutional support and will be almost certain to fall at the first attack directed against it in the courts.

Congress has already enacted certain legislation intended to regulate certain types of pollution which may threaten the conduct of free navigation. An example of such regulation is the Oil Pollution Act, by which the discharge of oil upon the coastal waters of the United States, except in specified contingencies, is prohibited. Another act prohibits the placing of refuse of any kind, other than that flowing from sewers and streets in liquid form, into navigable waters or tributaries thereof. Each of these acts attacks a possible menace to navigation and commerce.

A prohibitory measure enacted by Congress within the scope of the constitutional powers of the United States would be ineffective as against many conditions which must be corrected in order to clean up the rivers and streams of the country, and the enactment of any unconstitutional legislation would hinder, rather than help, the cause of stream purification.

Basic principles of act

In concluding the report, Mr. Biery emphasized the following points in the proposed Barkley-Hollister-Vinson stream pollution act which, he stated, are based on principles that have led to success in other federal aid enterprises:

(1) The stream pollution program is turned over to a long-established federal agency in a regular government department under long-experienced career personnel who have had years of experience working through state and local officials.

(2) The federal government does not attempt to do the work of controlling stream pollution. The actual abatement work is done by the states, with the full cooperation and encouragement of the federal government.

(3) The main basic principle is the matching of federal funds with states and municipalities, and the loaning of funds to states, municipalities, and industries, involving financial participation and responsibility for supervision of the actual construction by the state.

(4) The furnishing of funds to the state through state health department allotments for the maintenance of a continuous program for future work along these lines.

It is held by the Cincinnati Committee on Stream Pollution that with our present division of government, federal and state, the reservation of federal activity is in accord with customary normal procedure. In the absence of a mandate from the people as expressed in the constitutional amendments, no closer approach to the problem by the federal government is possible. Federal-state cooperation has succeeded in other fields of mutual interest, states the committee and there is good reason why it should succeed in stream pollution control.

Stabilizing Fine Dry Soil By Suboiling

By Carl B. Reid
Materials Engineer, State Highway Commission, Oklahoma City, Okla.

SUBOILING, *little known in the east, is rapidly becoming a well-controlled and important method of bituminous road construction in a number of states west of the Mississippi. The following article, extracted from a report to the Montana Bituminous Conference, 1936, describes a suboiling operation of special interest because of the dryness and exceptional fineness of the soil treated.* —EDITOR.

SUBOILING in Oklahoma is being undertaken in a section of the state in which the soil is very difficult to maintain as a dirt road, is too sandy to permit successful graveling, or where no gravel is economically available, thus providing what we consider an ideal situation for suboiling or a heavy oil mat made with existing materials. The average soil on this road is a typical A-1 (B.P.R. classification) with a plasticity index of 1.5; the amount passing the 40-mesh sieve is 94.8 per cent and that passing the 200-mesh is 40 per cent.

It happened that when this particular work was started the extremely dry weather had eliminated all moisture from the material to be treated. The water supply situation, in general, was such that it was impossible to arrange for any water to use before application of the oil. Tests in the laboratory indicated that about 10 per cent moisture in the soil provided the fastest and most thorough dispersion of the oil. We, therefore, doubted seriously the success of the work under these conditions, but were pleased to find somewhat satisfactory results. The oil used is SC-2 material, and was placed in the initial application at a depth of 5 to 6 in.

The suboiling machine was constructed by the highway department, and consisted of a 600-gal. oil distributor mounted on an old motor-patrol chassis. The oil was applied through teeth suspended in two rows from the blade circle. The teeth were spaced 6 in. and were staggered to give 3-in. intervals between lines of application. The total width of application was 8 ft. The unit was drawn by a 60-hp. tractor. It was found that the capacity of the machine was not sufficient to place the full quantity of oil at the rate of 1 gal. per sq.yd. per in. of depth and additional trips with the distributor were necessary, applying additional oil at higher levels to complete the final quantity. The first application was made at about 5 in. below the finished surface; the capacity of the equipment was increased by placing an additional oil tube behind each tooth and the full quantity of oil required was placed in two applications.

This road was so located it was necessary to permit traffic under construction. The fact that the scarifying and breaking up of the roadbed in this fine, granular material during dry weather, made it almost impossible for traffic of any description to go through presented a problem for those in charge. The practice, therefore, was developed of pulverizing the subgrade to the necessary depth and, when this was accomplished, blading out a section of this loose material. Just before the machine reached the section, this material was bladed back onto the road and shaped for the length of the round to be made by the oiler. During, and immediately following the application of the oil, a split-log type drag maintained a smooth surface and provided the only means of compaction which could be satisfactorily utilized.

By making the last application of oil at about 2 in. from the surface, a large percentage of particles were soon coated under the whipping of traffic, and some of the other loose surface material was blown or whipped off, so that it was found within a very few hours that the average vehicle had no serious difficulty in getting through. It is believed that it will be necessary, when it rains and more rapid dispersion of the oil takes place, to blade and manipulate the then existing surface to provide a uniform section upon which additional material to blot the surplus oil can be bladed in from time to time until final dispersion has been effected and a satisfactory surface obtained.

THE TENNESSEE RIVER EXPERIMENT—III

Navigation and Power on the Tennessee

River canalization planning by the Tennessee Valley Authority involves many physical and economic problems, including the relation of dam locations and the coordination of operating schedules to the needs of navigation, flood protection, and power production

DEVELOPMENT of 9-ft. navigation on the full 648-mile length of the Tennessee River from the Ohio near Paducah to Knoxville is one of the primary duties of the Tennessee Valley Authority, according to the law under which it works. Such development requires a series of dams with locks to convert the river into a chain of pools of adequate depth. Flood control also is required to be considered in planning the dams and their operation, and under the specific instruction of Congress the TVA is also providing for present or future development of the potential power at the dams.

In the detailed study of this river planning, many problems have been encountered. Chief among these is the evolution of plans for the combined operation of tributary reservoirs and the main stream canalization reservoirs to serve navigation and flood protection economically and effectively. A further slight complication in reservoir operation lies in the fact that malaria-carrying mosquitoes found in the Tennessee Valley area will breed in the shallow waters along the margins of the pools. It has been found that small fluctuations of pool level, made periodically, can control the breeding of these mosquitoes, and such fluctuations must be included in the operating plans. Studies of navigation terminals must also be made.

To indicate the possibilities of the projected canalization it may be noted that development of 9-ft. navigation throughout its full length will make the Tennessee River part of a 7,500-mile network of rivers and canals affording 6-ft. channel depths or more, as shown in Fig. 1.

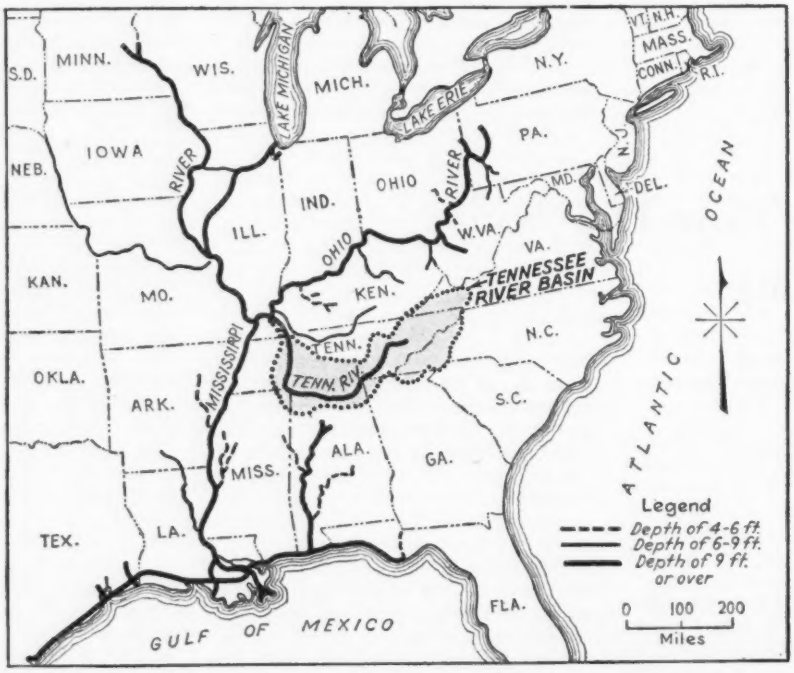


FIG. 1—THE TENNESSEE RIVER CANALIZATION will form part of a 7,500-mile network of internal waterways affording minimum depths of 6 feet or more

In its original condition the Tennessee River was of little use for navigation because of shallow depths, swift currents, and many rock reefs and gravel bars. At Muscle Shoals, rapids were a barrier against upstream navigation, while downstream navigation was possible only during short periods of the year; other major rapids included Colbert Shoals, Elk River Shoals, Tumbling Shoals, and Coulter Shoals. In spite of these handicaps, much commerce moved on the river as far back as early in the nineteenth century. Efforts to improve the stream for navigation began more than a hundred years ago. The earliest surveys for improvement of Muscle Shoals were made about 1820, and four years later the Secretary of War recommended to the President that the Tennessee be included in a broad program of waterway improvement. The main stages of the subsequent development were as follows:

During the four years 1831 to 1834 a canal was built around Big Muscle Shoals, about seven miles upstream from Florence, Ala., extending to the present site of Wheeler Dam. Further canal work authorized in 1871 was carried out at Muscle Shoals and Elk River Shoals. Again in 1890 Congress authorized an improvement, this time at Colbert Shoals. The section immediately below Chattanooga was improved by private construction of a power dam at Hales Bar, authorized in 1904 and completed in 1913, and this improvement was extended down-stream in 1916 by a navigation dam constructed by the federal government at Widows Bar, 23 miles farther down-stream. Wilson Dam, nearly at the foot of Little Muscle Shoals, was begun in 1918, and in 1926 the Florence Canal and Lock 1 at the foot of the shoals, just below Wilson, were completed.

Along with other major rivers of the country the Tennessee was made the subject of an elaborate study covering navigation, flood control and power authorized by Congress in 1927 under House Document No. 308. It was as a result of this so-called 308 Report (published in 1930 as House Document 328,

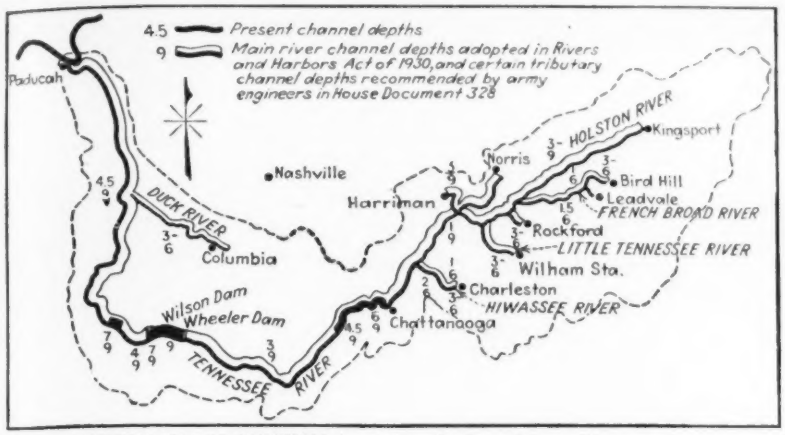


FIG. 2—**NAVIGATION IS IMPEDED** by shallow depths and by rapids even after a century's scattered improvement efforts

Seventy-First Congress, Second Session) that the River and Harbor Act of 1930 authorized improvement to provide a 9-ft. channel in the river from its mouth to Knoxville. Wheeler Lock was built by the army engineers under this authorization, using funds provided by the Emergency Relief and Construction Act of 1932; the subsequent location of Wheeler Dam, now under construction by the TVA, was fixed by this lock construction. In 1933 Congress entrusted complete development of the 9-ft. channel in the river to the Tennessee Valley Authority.

It will be noted that, prior to adoption of the present 9-ft. project, improvements had been made only at the worst shoals in widely separated locations on the river.

In spite of the inadequacy of existing depths (Fig. 2) a traffic varying from 400,000 to nearly 3,000,000 tons in different years has continued to move, but it is chiefly local movement of sand and gravel near large cities.

Type of improvement

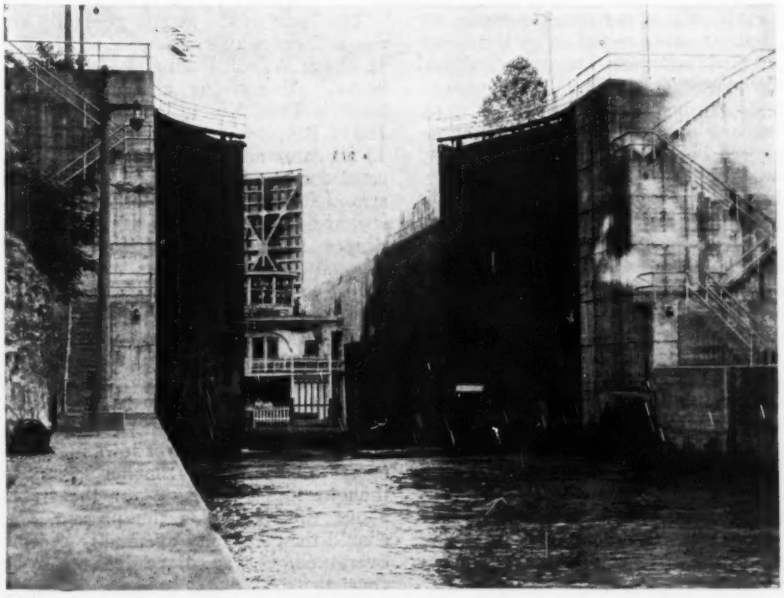
Physical conditions on the Tennessee River make canalization by dams forming a continuous series of pools the only suitable method of providing adequate navigable depths. Attempts to create the necessary water depths by channel works or by tributary reservoirs would be impracticable because of the impossibility of providing wide channels, sufficient depths, or reasonable velocities. However, in order that a river may be adapted to canalization it must have a stable channel and afford the proper dam sites; it must not be subject to excessively rapid silting, and sufficient water must be available to provide for lockage. Further, the construction must be cheap enough so that annual fixed and operating charges will not exceed the saving in transportation cost brought about by the navigation development. The army engineers, after their study, reported that these conditions exist on the Tennessee.

A series of low-lift locks and dams such as used on the Ohio River would be of limited value in developing the Tennessee. Navigation would be under handicaps because of the numerous lifts, the small pools subject to great fluctuation in stage, and the winding character of the channel; in addition the low dams would be valueless for flood control and would fail to realize the power potentialities inherent in the river's flow. As a project comprising a smaller number of high-lift dams is free from these disadvantages, it was recommended by the army engineers. The characteristics of the river are such as to require only a few dams (ten under the adopted system, or an average of one for every 65 miles of river length), the pools are large enough to straighten the winding channel by submerging some sharp bends, and flood control and power are made available.

Foundation conditions in much of the river's length are unsatisfactory, but at a number of places good rock occurs at attainable depths and the topography of the river banks is favorable for dams of a height suitable to the purpose—50 to 75 ft. These points, therefore, were chosen as the locations of dams, and each was then developed to such height as to form a navigable pool extending up to the next good dam site. Submergence of bottomlands and towns was, of course, considered. Railways and highways impose few limitations, as the Tennessee is one of the few major rivers east of the Mississippi whose valley floor is not continuously occupied by the principal railway and highway systems of the region.

Of the series of dams thus laid out, four are now under construction: Pickwick, Wheeler, Guntersville, and Chickamauga; these will provide 265 miles of 9-ft. waterway, or together with the existing Wilson Dam, Lock and Dam No. 1 and Hales Bar Dam a total of 316 miles. The locations of the three additional dams necessary to develop the main river completely will probably be in the vicinity of Gilbertsville, and at Watts Bar and Coulter Shoals. These will complete the 648-mile navigation length from the Ohio to Knoxville. Backwater areas on tributary rivers add 117 miles of 9-ft. waterway, making the total 765 miles.

FIG. 3—**THE LOCKS AT WILSON DAM** have a lift of 89 feet and are the only double-lift locks in the system



Traffic expectations

Traffic possibilities on the Tennessee were investigated by the army engineers in their study of the river. Their estimate, based on traffic conditions as of 1926 and transportation cost economies, indicated that a 9-ft. channel from Paducah to Knoxville in that year would

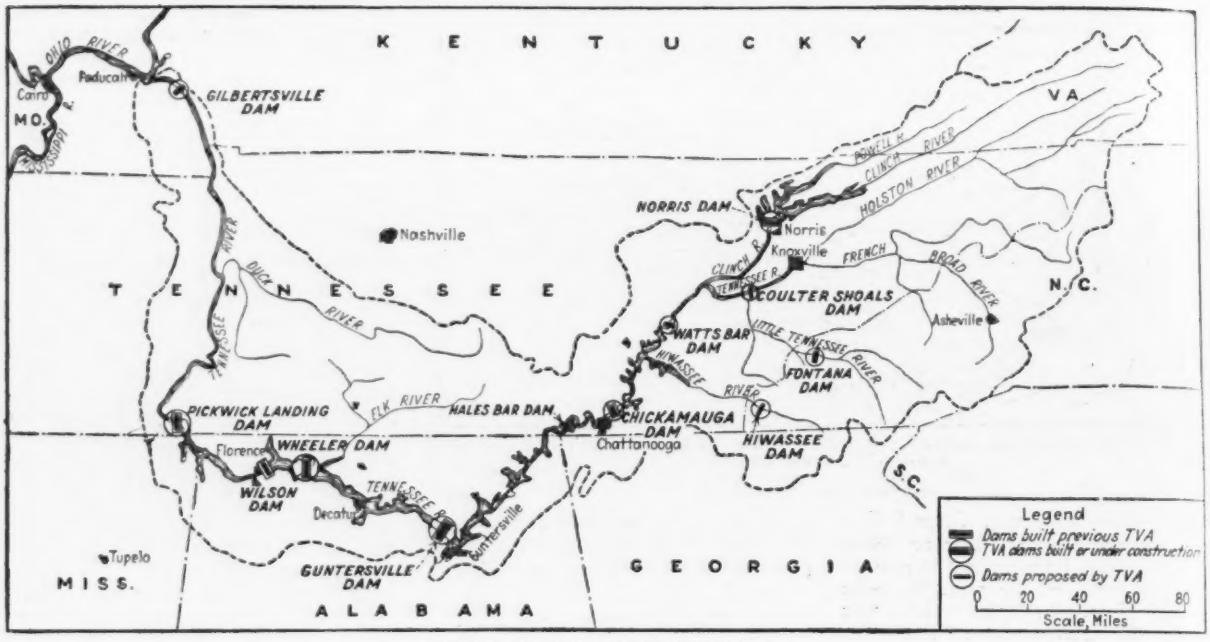


FIG. 4—THE ADOPTED SYSTEM of dams will provide a 9-foot navigable depth from Paducah to Knoxville

have carried 5,700,000 tons (about one-third as much as the Ohio or the Mississippi), at an annual saving in transportation charges of $7,300,000, and by 1950 no less than 17,800,000 tons, at a saving of $22,800,000. While the estimated traffic consisted mainly of bulk products (coal, timber, iron and steel, oil products, and grain) many manufactured products of higher class were included, such as automobiles, textiles, chemicals, canned goods and furniture. The TVA's later studies supported the belief that such articles can be transported by barge to advantage.

Large savings anticipated

Current traffic studies are not yet completed, but preliminary results show that very substantial savings in transportation costs will be realized through the improved waterway. They show also that important traffic possibilities exist on the Holston and Clinch rivers, and to a lesser extent on the Duck and Elk rivers and on the lower parts of the Hiwassee, Little Tennessee, and French Broad rivers. The phosphate fields of middle Tennessee are reached by the Duck and Elk, and improvement of these streams may prove to be of considerable importance in opening up the phosphate area.

In respect to traffic, the possibility of future extension of the improvement project beyond the limits now authorized has received consideration by the TVA. It was concluded that the following rivers might ultimately be developed for navigation: Duck River, Elk River, Clinch River, Holston River, French Broad, Little Tennessee, and Hiwassee. Whether these waterways should be improved for 6-ft. or 9-ft. navigable depth would depend largely on their cost and potential importance. They would add about 485 miles to the waterway length of the plan now authorized, bringing the total of the Tennessee system to 1,250 miles. There is also the possibility that an inter-connecting canal might be built between the lower Tennessee and the Cumberland and that the Tennessee might be connected by a canal through the divide to the Tombigbee or Warrior rivers, giving a direct connection to the Gulf of Mexico.

Tennessee River improvement would provide not only freight traffic facilities but also an important recreational value, it is held by TVA officials. The pools, easily navigable for pleasure craft, will afford an ideal means for the tourist navigator to enjoy the scenic beauty of both the broad agricultural valleys and the mountainous regions found in the Tennessee River area. Riverbank towns and many minor landings will be available to him as basing points for these pleasure cruises.

Freight transportation equipment is expected to be similar to that now used on the connecting waterways. The improved Tennessee will accommodate the largest Mississippi River barge, of 3,000-tons capacity. Tows propelled by one modern towboat and carrying up to 15,000 tons are expected to move at a lower ton-mile cost than obtains on other inland waterways, because of the better facilities provided by a high-dam system of development.

It is also expected that the waterways will counteract regionalization in railway rate structures; unduly high rate levels in the Tennessee Valley region are believed to react unfavorably on industrial development.

The finally adopted system of dams and pool levels is shown by the map and profile, Figs. 4 and 6. With the exception of the existing Dam No. 1, all locks will have relatively high lifts, varying from a minimum of 32 ft. at Hales Bar Dam to a maximum of 89 ft. at Wilson Dam, the lifts being computed at normal pool elevations. All of the locks will have a single lift except the existing structure at Wilson Dam, which is a double-lift lock. The highest single lift, 65 ft. at normal pool, will be at the projected Coulter Shoals Dam, and the minimum lift for locks constructed by the TVA will be at the Guntersville Dam, 39 ft. at normal pool.

Large locks provided

The locks of the system generally are single locks with chamber size 60 x 360 ft. above Wilson Dam and 110 x 600 ft. below. Exceptions are the existing locks at Dam No. 1, Wilson Dam, and Hales Bar, which are slightly smaller. In all dams under construction or projected for the future, space is being reserved for an auxiliary lock to be constructed at a later date if traffic conditions indicate a need for it. The adopted lock dimensions were determined by the existing lock size of the Ohio and Upper Mississippi canalizations and the practices as to barge sizes that have developed on these waterways. Provision of the larger locks at Pickwick and the proposed Gilbertsville Project is intended to permit the handling of large Ohio River tows upstream as far as Florence. Smaller locks are thought to be adequate for the traffic above this point for the present, and should their capacity eventually become overtaxed, the auxiliary locks can be constructed.

FIG. 5—THE LOCK at Pickwick Dam was started as the initial work on that project and now is well along toward completion

Believing that navigation is unlikely to develop unless adequate terminals are provided for shipping, receiving, and transferring freight, the TVA engineers in charge of navigation are studying terminals of different types and their possible location for effective service to the surrounding territory.

Both location and type of terminals are necessarily governed by the traffic. It may be expected to be relatively heavy at the more important towns along the river and where railroad interconnection can be had, and the larger terminals will probably be located at these points. At locations where less traffic will be handled, simpler terminals would avoid excessive overhead. Present studies are being directed to determining types of terminals and equipment for different traffic volumes and conditions of distribution. A typical river terminal is shown by the sketch Fig. 7.

Power development

The act setting up the Tennessee Valley Authority authorized the board of directors to "produce, distribute and sell electric power." In accordance with the policy thus laid down in the original act and amplified in amendments approved in 1935, the TVA has planned for either present or future development of power at those dams where head and flow conditions make such development feasible.

In deciding upon the desirability of power development at any particular dam, the Authority was guided by the legislative direction that stream flow shall be controlled primarily for navigation and flood control; where the use of storage for such control necessitates a much interrupted program of power generation, the question of the economy of part-time power development is studied before a decision is reached as to whether or not a power plant is to be built. This decision is affected by the fact that, as all plants are to feed into a general transmission network, even part-time generation can be made useful if the overhead cost of idle periods is not excessive.

As the result of these studies, intake structures are being provided at all of the projects now under construction, though at some dams no generating equipment will be installed at present.

The power available at the eight TVA main-river dams after equalization of flow by headwater storage reservoirs at Norris and Hiwassee (Fowler Bend) is given in Table I. However, as the generating equipment should provide for peak demand so far as the pool is able to furnish short-time supply to carry the peak the capacity to be installed is based on meeting such demands. Data on feasible peak installations are brought together in Table II, and these represent the capacities for which the intakes have been proportioned, though the designs are sufficiently flexible to permit of variation in detail should this later be found desirable.

The two tables present power facts based on the river-development plan reported to Congress by the TVA last March. These include eight main-river dams (or, with Hales Bar, a total of nine for the complete canalization) and two headwater storage reservoirs, of which Norris now has power equipment installed.

The plan is by no means final, however, as the best feasible development of tributary storage has not yet been fully determined and may not be decided on for some years to come, since a program of construction that requires many years for completion is subject to change in economic and physical conditions that cannot with certainty be foreseen. For this reason also the tabulated figures (Tables I and II) may have to be modified later on.

The total amount of continuous power available at several different stages of the Tennessee River Development, after deducting unavoidable energy losses, is given by Table III for both present machine installation (Wilson 184,000 kw., Wheeler 64,000 kw., Norris 100,000 kw., with no generators at other projects, and excluding Sheffield steam plant) and for full installation to develop the continuous power made available by the regulated river-flow.

Reservoir operation

A definite cycle of reservoir operation has been laid down to be followed in order that the storage will serve effectively for the purposes intended. During the flood season, December to March, inclusive, the headwater reservoirs are to be kept at low levels except temporarily when storing or retarding a flood. In some instances, where forecasting and down-river conditions make it possible, provision is made for maintaining a reservoir at a higher level, but it must be drawn down in advance of a flood. After the season of excessive flood-flow has passed, in the spring, the reservoirs may be allowed to fill, for release in low-water periods.

In the main-river pools, daily and weekly variations during the summer

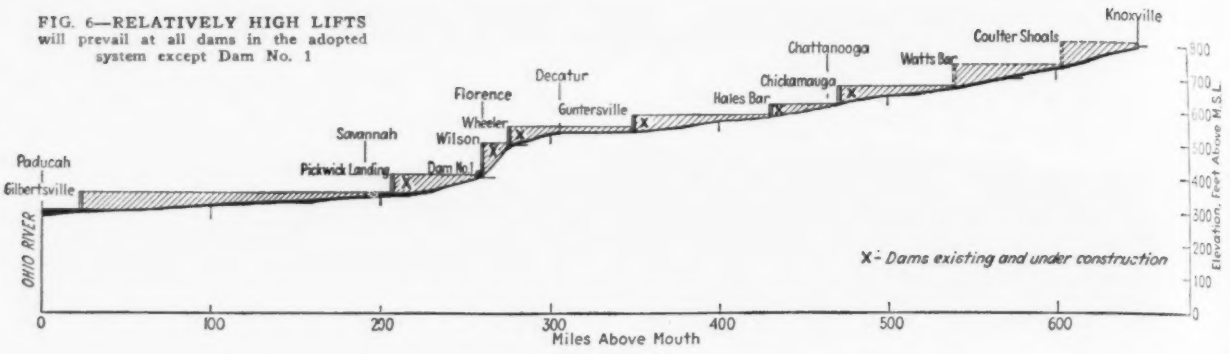


FIG. 6—RELATIVELY HIGH LIFTS will prevail at all dams in the adopted system except Dam No. 1

(April to October) are to be limited both to preserve navigation depths and to assure destruction of malaria mosquito larvae. As this will affect the river flow, it will not always be possible to develop as much power as the demand makes desirable.

During the flood season, which on the Tennessee extends from Dec. 1 to the first weeks of April, the main-river pools can be made effective for flood reduction by keeping them at the minimum levels that will give navigation depth at the head of each pool. But in advance of a flood the pools may be drawn down somewhat farther, the high flow at such times providing navigation depth by backwater rise.

Use of headwater reservoirs

Norris reservoir has the upper part of the storage area specifically reserved for the control of excessive floods. Some of the lower part of the reservoir will be available during most of the flood season as supplementary flood storage if the reservoir is filled no more rapidly than will ensure complete filling by spring.

In the other headwater reservoir, the Hiwassee (Fowler Bend) reservoir on the Hiwassee River, the same space will be assigned to flood control and flow equalization. Here the water will be held at low level throughout the flood season, and then the reservoir will be allowed to fill according to definitely prescribed rule curves, so designed that the reservoir can be filled by the time the storage (on the average) will be needed for low-water equalization.

Reservoirs of this type have less power value, when considered as isolated developments. Considered as part of a system of developments, however, they have great value through the increased low-water flow which they produce at downstream river dams. At times of high natural flow the main-river plants will produce sufficient power without help from the headwater storage, while in the low-water season the releases from storage produce power both at the headwater dams and at river plants.

At some of the main-river plants a special condition is encountered with respect to power output during extreme floods. These are the plants at which flood flow raises the tailwater so much as to reduce the head greatly, decreasing the power below the dry-season capacity. In these cases the lower output at flood time becomes the controlling factor in determining the plant's contribution of prime power to the system. The deficiency in peaking capacity must be made up elsewhere in the system, and this is possible by use of the generating capacity at the headwater reservoirs for the short duration of the peaks. While such operation requires the release of a certain amount of water from the upper reservoirs during floods, the amount required would be an insignificant addition to the flood flows in the main river.

So long as the series of canalized pools is not complete there will also be some conflict between the respective requirements of navigation and power. In this uncompleted condition the release of water from storage to meet navigation requirements will usually not fit the variable requirements of power demands, and since navigation is primary there will be a certain sacrifice of power possibilities. However, by the time the main river is completely canalized this interference will largely disappear. And further, when this stage is reached the irregularity in releases of water from storage to suit power demands would probably be smoothed out by the time the water reaches the mouth of the river. It may therefore be expected

TABLE I
EFFECTS OF WATER REGULATION ON PRIME POWER CAPACITY MAIN RIVER PLANTS

Project	Minimum Weekly Flow Sec.-Ft.		Average Head (Ft.)	Continuous Power Corresponding to Regulated Flow (Kw.)
	Unregulated	Regulated		
Coulter Shoals	1,700	2,400	64.5	10,000
Watts Bar	2,900	12,400	62.5	54,000
Chickamauga	3,500	16,500	44.5	51,000
Guntersville	4,100	17,000	38.5	46,000
Wheeler	4,150	19,300	48.5	65,000
Wilson	4,300	19,600	91.0	129,000
Pickwick	4,350	19,700	52.0	71,000
Gilbertsville	4,400	23,700	47.0	77,000

TABLE II
SPACE PROVISION FOR GENERATING CAPACITY

Project	Drainage Area (Sq. Mi.)	Normal* Head (Ft.)	Proposed Capacity (Kw.)
Norris	2,950	129–194	100,000***
Hiwassee (Fowler Bend)	977	143–254	80,000†
Coulter Shoals	9,600	65	60,000†
Watts Bar	17,500	63	150,000†
Chickamauga	20,800	47	100,000
Guntersville	24,300	38	100,000
Wheeler	29,600	50	256,000***
Wilson	30,800	91	444,000**
Pickwick	32,900	53	204,000
Gilbertsville	40,000	52	256,000†

* With normal headwater elevation, and tailwater elevation corresponding to 50 per cent of the annual average flow.
** Provision in the existing plant.
*** Capacity of 100,000 kw. is now installed at Norris and 64,000 kw. at Wheeler.
† Inasmuch as the investigations covering Gilbertsville, Watts Bar, Coulter Shoals, and Fowler Bend, are still in preliminary stages, the final recommendations pertaining to these projects may indicate more or less capacity than shown by the table.

TABLE III
POTENTIAL CONTINUOUS POWER

System	Continuous Power with Present Installation (Kw.)	Continuous Power with Possible Future Installation (Kw.)
Wilson, Wheeler, Norris	205,000	205,000
Wilson, Wheeler, Norris, Pickwick	205,000	265,000
Wilson, Wheeler, Norris, Pickwick, Guntersville, Chickamauga	215,000	255,000
Wilson, Wheeler, Norris, Pickwick, Guntersville, Chickamauga, Hiwassee (Fowler Bend)	225,000	400,000
Wilson, Wheeler, Norris, Pickwick, Guntersville, Chickamauga, Hiwassee (Fowler Bend), Watts Bar, Coulter Shoals, Gilbertsville	.....	535,000

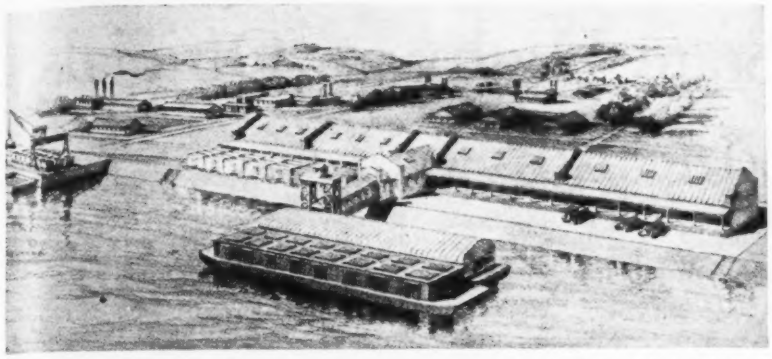


FIG. 7—RIVER TERMINALS are to be designed to meet local needs and for flexibility

that the full benefits of storage regulation would accrue to navigation on the Mississippi River.

Again, prior to complete canalization, the main-river plants are subject to the limitation that enough water must be passed through them to maintain minimum navigation depth over the critical bars and shallows downstream. Thus, so long as the dams below Wilson are not all built, no water is to be stored which would reduce the natural flow below about 15,000 sec.-ft. at Florence. When the river flow is as small as this the Wilson plant cannot be used for meeting load variations, but when the flow has increased sufficiently to remove navigation difficulties, this limitation on its operation will disappear.

Operation for mosquito control

As already mentioned, the danger of increasing the propagation of malarial mosquitoes is an extremely serious one in the malaria-infested riverside areas of the Tennessee. The main-river reservoirs will add so greatly to the shoreline of the river, where shallow waters create ideal mosquito-breeding conditions, as to make intensive study of the malaria problem a matter of first importance in respect to reservoir operation.

Studies of the life-cycle of the anopheles mosquito have shown that a highly effective control of malarial mosquitoes may be attained by checking the growth of plants along those portions of the reservoir shore which are subject to alternate submergence and exposure from reservoir fluctuation. Under these conditions, planned fluctuation of water level is successful in killing the mosquito larvae by stranding them on a clean shoreline. The procedure for fluctuation is still in a state of development.

With respect to the periodic fluctuation for malaria control during the breeding season, it appears that in many cases the natural fluctuation of pool level due to varied power draft would produce fluctuation sufficient for malaria control. During the initial stages of development, however, it will not be possible to obtain the necessary malaria-control fluctuation without reducing the prime power materially.

Centralized water control

Consideration of these operating requirements brings out the importance of centralized control of water storage releases along the full length of the river. The desired service to the several uses—navigation, flood control and power—is seen to require close regulation of water levels and storage reservoir operation, which is obtained only by completely coordinated cooperation. The TVA accordingly has believed from an early stage in its existence that there should be coordinated control of the operation of all reservoirs on the river and its tributaries, both of privately or publicly owned. It holds that the system cannot be operated most effectively under any other form of control.

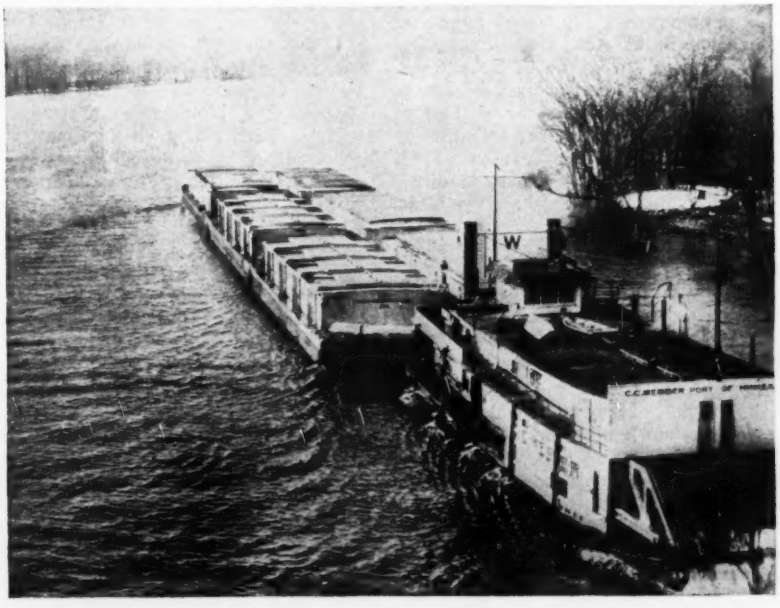
Subject to this unification of control, it believes that the broad results of comprehensive river development will be substantially the same whether certain projects are carried out by private or by public interests.

Direction of the work

Like the general storage and flood-control problems, the planning for navigation development and the hydraulic elements of planning for power generation are in the planning division of the engineering department of the TVA, under S. M. Woodward. The electrical side of power generation is handled by the electrical engineering department. Heading the organization dealing with these subjects are Barton M. Jones, acting chief designing engineer, C. T. Barker, senior hydraulic engineer, Dana Wood, principal hydraulic engineer, J. H. Alldredge, transportation economist, on the hydraulic side; and Llewellyn Evans, chief electrical engineer, W. W. Woodruff, engineer of design and construction in the electricity division, and Edward Falck, director of rates and research on the electrical side. Numerous consultants have been called in, especially in connection with the problems of dam foundations and construction. Profs. Warren J. Mead, Charles P. Berkey and L. C. Glenn, geologists, have consulted on foundation problems. Engineers consulted on dams and hydraulic questions include William F. Uhl of Boston, Charles H. Paul of Dayton, L. F. Harza of Chicago, John L. Savage of the Bureau of Reclamation at Denver, O. N. Floyd of Dallas, Thaddeus Merriman of New York, Charles H. Locher of Knoxville, and G. W. Hamilton of Chicago.

The fourth article of the series will be published next week.

FIG. 8—MODERN TOWS carrying up to 15,000 tons will move on the improved Tennessee



Meeting of State Highway Officials Stresses Education of Drivers

Death toll still major topic—Human problem now paramount—Attendance more than double any previous meeting of American Association of State Highway Officials

WAYS AND MEANS of decreasing the death toll of highway accidents was again the major concern of officials from 44 states who gathered in San Francisco last week for the 22nd annual meeting of the American Association of State Highway Officials. The registration exceeded 780 members and guests; more than double the number at any previous meeting. Many of the more important papers dealt with safety problems, as was the case last year, but this time there was decided sentiment that there must be more education of and more cooperation from drivers of motor cars. Several leading papers dealt with one or another phase of safety but greatest emphasis was given to the requirements and the responsibility that must be placed upon the drivers of motor vehicles. Other highlights of discussions were the importance of safeguards for night driving, the probability of increased rather than decreased average speeds, and the need for more uniformity in road markings and in state speed laws.

In the roll call by states only four did not respond; at least half a dozen states, some as far away as Florida, sent large, representative delegations. A comprehensive, illustrated paper on construction of the San Francisco-Oakland Bay Bridge by C. E. Andrew, bridge engineer, California Division of Highways, was followed by an inspection trip to the structure; tribute was paid by numerous speakers to C. H. Purcell, chief of the division in direct charge of this $77,000,000 state highway structure.

In the annual address of the president, Gibb Gilchrist, Texas state highway engineer, pointed out that speed is with us to stay; that most cars on the open highway exceed legal speed limits and that states can be measured and compared by the way in which they handle their highway problems. All states are much alike in regard to the federal aid system but in other respects the highway problems may be as different as is their topography. Stress was placed upon the importance of planning at least three years ahead in programming highway construction and still further in advance on planning. He spoke against the defacement of highways by billboards, referred to diversion of gasoline tax funds as a form of "legal pickpocketing" and urged courteous and considerate treatment of the traveling public by highway construction crews.

More responsibility on drivers

In a paper on highway safety as exemplified by properly designed and constructed highways by R. E. Toms, chief, division of design, U. S. Bureau of Public Roads, stress was placed upon the human element as the major factor in safety campaigning yet to be done. The trend is to higher speeds. Contrary to the impression in some quarters, the cause of most accidents is not high speed; total fatalities in terms of highway usage were less in 1935 than in 1920 when speeds were materially lower. Less than three per cent of the drivers were involved in serious accidents last year. More than half the fatal accidents occur at night when not more than one-quarter the traffic is moving.

Support of the viewpoint in favor of more attention to drivers was presented by Sidney J. Williams, director, public safety division, National Safety Council. He favored zoning highways for speed so as to give the maximum advance information to drivers and stressed the importance of educating drivers, particularly in the matter of appreciating what speed means under different conditions. The driver is entitled to laws that do not change as he crosses the frequent state lines, to laws that can be understood and that mean what they say, as our present low limits on maximum speeds do not. A keynote in Mr. Williams' address was the statement that "it may be true that we can't change human nature but we certainly can influence human behavior."

Discussions in the general sessions brought out the fact that existing regulations as to speed are generally unsatisfactory and not conducive to safe operation. Consensus of opinion indicated hope for a system of normal maximum speed zones which would take into consideration the physical condition of roads in each zone as well as normal volumes and nature of traffic with possibly lower speed limits at night or while special conditions prevail. The most effective means of reducing highway accidents was agreed to be effective training for drivers, keeping incompetent drivers off the highway and providing and enforcing practical, uniform regulation for vehicular operation. In furtherance of this view it was recommended that the highway safety investigation, now being carried on by the Bureau of Public Roads, be directed especially to determining habits and practices of the driver.

There was general agreement that instruction in driving motor vehicles should be given in the public schools and should include the teaching of rules for pedestrians. Further editing and revising of the Manual of Uniform Traffic Control Devices was recommended. A new phase of the right-of-way problem was presented with the suggestion that legal means should be provided for acquiring lands by eminent domain on which to move valuable structures that have to be taken over by the state in widening highways and enlarging intersections. California and Ohio now have such laws; they would be of great advantage to all states.

Figures mentioned in several sessions and used in computations were: total motor vehicles now in the United States 26,000,000; total drivers 44,000,000; number of accidents last year, 827,000; total fatalities in 1935, 37,000.

In line with the sentiment that an important need now is education of the public, a half-hour broadcast on Tuesday evening took advantage of the opportunity to use for publicity purposes the presence of highway authorities. The interview plan was used to bring out the fact that there is no such thing as a foolproof highway. It is not speed that is primarily to blame for accidents but operators must learn where speed is not safe; potential power in a motor car ofttimes is a factor of safety. Road design is being improved; 2,000 grade crossings are being eliminated; highways continually are being made safer so far as hazards that are built into the road are con-

cerned, but in the safety triangle of road, vehicle and driver, the road itself is least important and the driver is by far the most important factor.

The broadcast concluded with a questioning of four state highway engineers as to contributions to highway safety made in those states. Florida reported that a 200-ft. strip of land now is secured when getting new rights-of-way. Because the population of this state doubles in wintertime, bringing many drivers from other states, emphasis is placed upon standardizing traffic rules and signs among the states. Indiana reported reduction of accidents by one-half in a period of three years through the widening of primary and secondary roads to 100 ft. and 80 ft. respectively, together with improving sight distances on curves and elimination of grade crossings. The most perplexing problem there was said to be modernization of bridges and culverts.

Materials and maintenance

The grading of aggregates for dense-graded bituminous mixes was described by I. E. Russell, engineer of tests, Wyoming Highway Commission, and resultant discussion centered around low cost roads in which the problem is to design the mix to fit the aggregates that are locally available. Research work on cutback asphalt versus bituminous emulsions for road work and the possibility of accelerating viscosity tests of liquid asphalt materials were reported by N. M. Finkbinder, engineer of tests, Oregon, and J. W. Powers, testing engineer, Arizona State Highway Commission. California was stated to be the first state to do research work on pre-molded expansion joints for concrete, as the result of which there have been developed rubber, cork and other non-extruding pre-molded joints which simplify maintenance.

For bituminous roads, W. H. Wood, testing engineer, Texas State Highway Commission, presented data on means of recognizing asphalt produced by the so-called cracking process. Further data on service tests of such products are needed, he said. German research work was reported in which it has been found that the type of aggregate has greater influence on the adhesion of bituminous materials than does the kind and type of such binders. Although there is some difference of opinion on this score enough information has been developed to warrant careful study of whether better adhesion with bituminous materials is obtained with basic, alkaline rock or with rock of an acid nature such as granite and sandstone.

Efficient service to the motoring public was the keynote of discussions under the head of maintenance. Papers were presented on "Maintenance of Detours Under Heavy Traffic," by T. H. Dennis, maintenance engineer, California, and "Caring for Slippery and Icy Pavements," by G. H. Delano, chief engineer, Department of Public Works, Massachusetts. Further studies were suggested on lighting of highways, traffic signals, the marking of safety zones and patching to avoid hazards at high speeds. A paper on the relationship of maintenance costs due to climatic conditions and costs directly chargeable to the volume of traffic was presented by J. B. Early, maintenance engineer, Texas, in which he explained that traffic alone is not always the determining factor in the ultimate maintenance cost. A paper on roadside trees and shrubs by J. N. Bishop, maintenance engineer, Oregon, stressed the importance of flattening and rounding slopes with ground cover as a means of decreasing erosion. Consensus of opinion opposed formal planting.

Maintenance of mountain highways was described by Lacey V. Murrow, director of highways, Washington; in his state the highway system includes two mountain passes where the snow fall exceeds 600 in. per year and two others where it exceeds 400 in. In Snoqualmie Pass, the main east-west mountain highway last year a 420-in. snowfall was handled with road closure totaling only six hours. Radio communication was essential, he said, to effective operation of snow-fighting crews which last year removed 35,000,000 cu.yd. of snow, much of it wet enough to weigh 40 lb. per cu.ft.

Recent developments in highway research were outlined by H. S. Mattimore, engineer of tests, Pennsylvania. He sounded a warning against dangers of over-vibration in concrete. He also pointed out that accident risk at night is four to six times as great as in daytime, which places corresponding importance on safety aids to night driving. The time is approaching, he said, when the engineer may be able to specify a type of cement specially suited to the conditions to be met. In discussing treatment of road surfaces glazed by ice, the principal remedies mentioned were salts (CaCl or NaCl) and sand. In some cases sand is applied hot as an aid in embedding gritty particles. Slides and frost boils were cited as topics needing further investigation.

Highway planning

State-wide highway planning surveys was the subject of a comprehensive paper by H. S. Fairbank, chief, division of information, U. S. Bureau of Public Roads, in which stress was placed upon the importance of studying highways as a department of transportation in the broadest meaning of the term. The relation of highway transport to all other forms of transportation must not be overlooked and plans must be made not for "building" roads but for keeping roads in condition of maximum serviceability. State-wide planning surveys now are under way in 40 states, he said. In these studies attention is given to the condition of highways, their financing, administration and their relation to general economic and social trends. This work begins with an inventory of the extent and condition of rural routes and includes information on the amount of traffic, causes of congestion, analysis of highway accidents, probable future growth, and estimate of financial resources of the state with respect to tax money that will be available for supporting a road system.

Association policies and standards

Because the available skilled and semi-skilled labor is estimated to be 40 per cent less than in 1929 and because the quality of highway work is largely dependent upon intermediate or skilled workers, it was recommended that contractors on public work be required to obtain from designated or specified agencies only unskilled labor. This would tend to increase wages of competent skilled labor and would benefit both labor and the public.

Because of the seasonal character of highway work, it was suggested that the maximum hours of labor be specified on a monthly instead of a weekly basis. In the highway industry the average of only 200 working days per annum (because of weather conditions) suggests that both labor and public would benefit by permitting a maximum of 200 hours of labor per month.

Increasing attention to scientific control of methods of compacting earth-fills were reported from a number of states. Investigation and research along this line will be continued. During the coming season specifications for concrete pavements and bituminous-filled brick pavements will be amended. Also attention will be devoted to coordinating nomenclature in the field of bituminous treatment on bases of local material.

In a week of sessions preliminary to the convention the committee on bridges and structures revised the 1935 edition of the association's bridge specifications, approved new timber stress gradings, adopted and planned to print soon a specification for movable bridges, worked on a comprehensive manual of bridge construction and adopted the section on concrete. Welding should progress slowly, it was agreed, until more is known about the fundamentals.

The committee on uniform accounting, reorganized in September, held a series of four regional meetings last month (Missouri, Texas, Georgia and Ohio) and has four more planned for the near future (Denver, San Francisco, Washington and Boston). This committee indicated the belief that

accounting organizations in state highway departments are primarily service organizations; a major function is to provide adequate and accurate cost and statistical data for management purposes. After a careful study of the procedure and methods in various states the committee plans a manual setting forth uniform accounting classifications and procedures. H. D. Barnes, Kansas, chairman of the committee, is to appoint a committee of eight to survey accounting problems in their respective regions and later to select three of its members to prepare the accounting manual to be presented and discussed at the next annual meeting.

A new association activity, the committee on public relations and publicity under the chairmanship of J. D. Adams, Indiana Highway Commission, urged upon state highway departments the necessity of keeping the motoring public advised concerning highway transportation costs and needs. Last year there was costs and needs. Last year there was diversion to other uses of $146,000,000 in gas taxes and license fees, representing an increase of $24,000,000 over the preceding year. The trend of public opinion against this practice is shown by the constitutional amendments enacted in five states prohibiting such diversion. Well directed publicity is the best method of combating this diversion and to that end public relations work should be put in the hands of trained personnel. Public addresses, radio talks, motion pictures and magazine articles should be kept before the public. A well defined policy of disseminating information on highway problems and highway programs would do much to win for the transportation industry the determined support of the motoring public. No state highway department can consider its organization complete until there is provision for keeping its financial backers and stockholders—the motoring public—adequately informed as to its operations.

Among matters recommended for association action by the committee on administration were (1) the appointment of a committee to confer with railroads as to methods of financing grade crossing elimination, (2) that Congress be requested, in the event of future appropriations for relief labor on roads, to provide for expending such funds through the U. S. Bureau of Public Roads and through the several state highway departments and (3) that federal aid should be made available for maintenance as well as for road construction. On this last point objection from the floor arose immediately. R. H. Baldock, Oregon state highway engineer, pointed out that a federal maintenance program would weaken morale in the state commissions and would tend to nationalization and bureaucratic control of local matters in an undesirable way. There was general support among those present for Mr. Baldock's views.

Resolutions adopted in the closing session approved extension of federal aid in secondary road systems; favored a longer working month under federal aid, copyrighted markings on numbered highway route markers, continuing cooperation with Central American republics on highway work, and furthering the interests of an Inter-American highway south of Panama as well as the International highway already planned to extend from Fairbanks, Alaska, to Buenos Aires.

Road design standards previously adopted by the association have been revised; a 1937 model soon will be available. A summation of principles for intersection design is being prepared; soil surveys are recommended as factors in the selection of the best available subgrade materials and stress is placed on the importance of including landscaping as an integral part of road design.

Election of officers for the ensuing year resulted as follows: president, T. H. Cutler, Kentucky; vice-presidents for the four zones, respectively, John V. Keily, Rhode Island; R. A. Harris, Mississippi; E. Lieberman, Illinois and James B. True, Wyoming.

Tomorrow's Roads

What the lessons of Europe's active modernization of its highways and the pressure of our own growing road use teach as to coming road development and reorientation of the national highway program.

By Thomas H. MacDonald

Chief, U. S. Bureau of Public Roads
Washington, D. C.

IN A REMARKABLE ADDRESS *to the San Francisco convention of the American Association of State Highway Officials last week, the federal road chief set forth the new directions of road planning and road-building that must be followed in making our highway network an efficient service agency. His illuminating sketch of the work of the principal nations of Europe in building modern highway arteries to supplement their ancient local roads, reproduced here in slightly condensed form, forms an interesting background for his forward-looking statement of whither our own work is tending.* —EDITOR.

TO DRIVE a modern motor car a quarter of a century into the past is an illuminating and valuable experience. In a public enterprise such as ours—the building of a system of universal highways for a nation—the test of time is all important. It measures the adequacy of the vision into the future. My recent opportunity to study traffic conditions in many of the countries of the old world clarified many uncertainties and indicated the very definite directions that federal and state highway policies of the future should take.

Some eight years ago I inspected the newly completed Great West Road leading out of London. The construction had been undertaken for the purpose of providing employment, but its conception was to provide a wide thoroughfare of large traffic capacity to permit uninterrupted flow between the heart of London and the suburban and rural districts to the west. The roadway was paved at least 50 ft. wide, and designed to carry heavy units. At that time a considerable part of its length was bordered by open fields. Today it is lined by continuous large industrial enterprises of many kinds. Traffic conditions are as congested as on the roads previously existing which this new highway was expected to relieve. It has lost its visioned function to move traffic expeditiously over a considerable distance, and has become a crowded local-service road.

If this actuality is projected against the bypass designs which are in common use here, there is no essential difference in either conception or design. The experience in this case leads directly to the conclusion that where the population is sufficient to make desirable bypass or radial distance routes, population and industries will gravitate rapidly and certainly to the new highways. Because of the better traffic facilities offered, new enterprises will come into existence, and *within a surprisingly short time we have only another city street with congested traffic.* It soon loses its ability to serve the original purpose.

The trend everywhere is so clearly defined as to make the conclusion inescapable that on bypass or through routes separate roadways must carry the through and the local traffic, and the local traffic must be so adequately served that it will be necessary to give access to the through highways at only infrequent intervals.

France presents the opportunity to observe major projects undertaken for the relief of street and highway con-

gestion in the metropolitan area of Paris. Here we get the conception of the dynamic instability of the great population centers when new transportation facilities become available. Highways and bridges of the time of Louis XIV and Napoleon are yet in service, a tribute to the ability and courage of the engineers and architects of a century and a half ago. Today, however, major projects, forced by the growth of street and highway traffic, are under way that will greatly modify and facilitate transportation in the area; but all are in harmony with, rather than destructive of, these sterling traditional values.

So carefully are the projects designed to accord with the existing comprehensive plan for remodeling the city, with the old but few fine buildings, with the principal boulevards and streets, and with the parks and other important public areas, that on completion they will have added greatly needed facilities presenting the appearance of graceful growth. We can get wisdom from what is being done there for two good reasons: first, the plans have been developed and the work is being executed by the national department of highways, the whole personnel of which has been trained in the Ecole des Ponts et Chaussees, the school of roads and bridges, whose beginnings go back at least to Louis XV and possibly before. Second, there is the test of time:—one and one-half centuries permit a sound perspective that distinguishes between enduring principles and short-lived stopgaps.

Belt highways and radials

So it is of the highest significance that the competent French department of highways has selected, to meet two problems of traffic congestion, two distinctive types of highway planning: first, an intercepting circular highway enclosing the city, and second, radial highways reaching for a considerable distance beyond the city to connect with the existing national highways.

There was a time when Paris depended for defense on fortified walls extending around the city. At intervals, gates provided for the flow of traffic to all parts of the nation; these lines yet remain the major radial highways within and without the city. On the location of the old fortification a modern highway is under construction. The abandoned walls have long since served their purpose, but through the years has been preserved, free from encroachment, the land which now becomes the right-of-way for a highway that will serve to carry traffic rapidly to connections with all of the radial streets and highways in and out of the city. At intersections the new circular highway is carried under the major radial routes.

At some points these underpasses are relatively simple tunnels, beginning and ending far enough back of the intercepted streets to leave their full width available for traffic. Others are multiple-lane tunnels branching to connect with several streets. A feature that is new and highly desirable is the equalization of the intensity of lighting within and without the tunnels. This is accomplished automatically by the use of the photoelectric-cell control, an achievement in tunnel lighting that destroys the unpleasant reactions to driving underground.

As a part of this new development program, many of the old city bridges over the Seine are being replaced by new structures, but great care is taken to preserve the architectural harmony of the new with the old. These examples typify the plans to expand highway facilities to meet new conditions where the problem is one of adding to a system of highways originally laid out on a well conceived national basis.

Superhighways in Germany

In Germany a wholly different situation is met. Until the present National Socialist government took over the development of a national system of highways, in 1933, the work was on a state and local basis. The situation is graphically described by Dr. Allmers, president of the national association of the motor industry of Germany:

"In Germany there was a hopeless state of disintegration as in the Middle Ages. State and provincial governments, district and communal authorities, made every effort to obstruct a sound development based on uniform principles. The Ministry of Transport was powerless, and years elapsed before applications were sanctioned by the competent governments of the federal states. Every district road engineer built his roads in a different way, but nearly all of them built them in the wrong way, and only a few appreciated the requirements of automobile traffic and these few mostly lacked the necessary funds."

Here no national system had been planned and developed through the years, so it was necessary for the present German government to attack the problem of adequate national highways at the beginning. A two-part program was undertaken—the rehabilitation of the existing roads, which have been divided into national roads and highways of the first and second class. The work on these latter classes is administered, under general direction of the Inspector General of German roads, directly by the states and provinces. The second part of the program is the laying out and construction of a wholly new system of roads known as the *Reichsautobahnen*, under the immediate supervision of the General Inspector.

The system as planned consists of about 4300 miles, which gives roughly three lines across Germany north and south and three east and west. The literal translation of the word *Reichsautobahnen* is national auto road, which gives immediately a vision of these great national thoroughfares, built on their own new wide right-of-way to provide for a continuous flow exclusively of motor traffic over the whole mileage without conflict with the cross traffic on intersecting highways or railroads. The design calls for very easy gradients, long sight distances and long-radius curves.

There is some difference in standards as applied in different areas, depending upon the general topography. The section design calls for two roadways, each 29 ft. in overall width, separated by a sodded strip 13.65 ft. wide. Each roadway consists of a Portland cement concrete slab 24.37 ft., an inside curb 1.3 ft., and an outside curb 3.25 ft. in width. These curb strips are covered with a bituminous mix, thus giving the grayish-white center a wide black border. Cross highway traffic is generally carried over the *autobahnen* without materially raising the level of these cross roads, meaning that sections of the *autobahnen* are placed in deep cuts. The *autobahnen* in some cases are carried over railways. Various types of access roads have been developed, depending upon the actual amount of traffic eventually expected. The cloverleaf design is in less general use with its four-way connections than the trumpet design. At the present time, upwards of 1000 miles of the *autobahnen* have been completed, although all of this mileage is not as yet open for public use.

Building roads ahead of traffic

As a national system, relative to the area of the country, this conception goes far beyond any modern similar undertaking by any nation, when measured by miles, by the generous dimensions of the typical design, and by all of the auxiliary work, including structures, approaches and landscaping.

The construction features, as will be inferred from the description of the carrying of the *autobahnen* below cross design, involve heavy grading. The roads to provide high clearances alone accounts for heavy yardage because of the wide sections. The slopes are designed to permit the quick establishment of ground cover, and all the work, even that recently finished, is well sodded. The topsoil has been conserved and replaced, and in an inspection covering most of the completed mileage there was no evidence of unprotected slopes or destroying erosion. Mechanical equipment in service is for large-scale production.

There is little basis for comparison of this undertaking and the highway improvement going forward in this country. Here the highway builders have been waging an almost losing

struggle to provide highways for the already developed motor traffic. In Germany the system of superhighways is being built largely ahead of the highway traffic. Germany has recognized the utility of highway transport to the extent of having embarked on the building of these large-capacity highways, and as a complementary national policy there has been put into effect every inducement to encourage the development of motor traffic.

In all of Europe the motor car has previously been looked upon as a luxury and taxed as such. The relatively slow development there resulted from high-priced cars and taxation handicaps against their utilization. Germany has not only done away with special taxes on the motor car in recognition of its potential general utility, but is actually permitting the cost price of trucks and business cars to be deducted from income on which taxes are paid. The encouragement thus offered by the government has been so outstanding that the licensing of new cars jumped from 41,000 in 1932 to 180,000 in 1935—an increase of 340 per cent.

In addition the industry has been brought under governmental supervision, so that the commercial practices which had brought demoralization of the business have been rectified. Those most importantly interested now give highest praise to the stabilization of the industry which has thus been effected by the government. Here we have an unusual expression of faith in the utility of highway transport. While the highway program was undertaken as one of the means for providing employment, which, according to reports, in 1932 reached one out of each three who were able to work, the policy of highway building represents a large investment on the part of the government which there is no immediate possibility of recovering directly from imposts on the road users.

A program for the United States

Since conditions are so dissimilar, what relationships are there, then, which we can take as warning or which we can emulate?

The most important is that we must grasp this highway problem in this country more firmly. We must raise our standards to the new levels demanded by the universal utility of the motor vehicle. Two distinct programs are indicated. First, the systematic rehabilitation of existing highways by the actual incorporation of new construction to promote safety and greater utility. Second, the long-time plan, which will be based on the principles illustrated by these examples from other countries and on wide experience in our own country.

The highway transport surveys now under way are basic. It is my hope that the highway department of each state will recognize the essential quality of the information which is being gathered. If the program of the next five to ten years is to provide the public with highway service that is not now even approached in any state, it must rest on this transport survey foundation.

The underlying soundness of planning an intercepting belt-line highway plus radial roads on new right-of-way to serve the metropolitan areas, and introducing the new feature of providing this complete service only for the passenger motor vehicle, is supported by the traffic studies heretofore made. These studies indicate the overwhelming preponderance of passenger motor vehicle movements in the metropolitan areas, particularly on week-ends and holidays. To provide free-flow highways leading from the cities well into the country, and to permit the distribution of vehicles on these radial highways from and to their own quadrants in the city over one or more belt-line highways, will add immeasurably to the potential utility of the motor vehicle to the urban dweller.

This conception goes farther, however, and recognizes that the trend of the world is toward a greater recognition of social values. The motor car is one of the instruments from which we are not securing the potential social services in the nightmare of congested streets or highways at times of peak traffic.

There is need in some limited sections of the country for the extension of such roads until they connect with those radiating from other large centers of population to form continuous routes wholly disconnected from our present system of highways. To the extent that other traffic, such as pedestrians or bicycles, may use such routes, separate ways must be provided. But the design must go a step farther than does the design of the German, the French or our own roads, and provide for the complete separation of local from through travel by parallel service roads. *We must accept as an essential the separation of grades at major highway intersections.* This is one of the most important factors in stepping up the safe utility of our existing highways.

Eight hundred millions a year

The problem of unemployment is yet with us, and to a large degree will remain with us, but we can in addition recognize more fully that we must look intelligently at what we are doing, and determine the method of attack on those problems of highway traffic that are growing constantly more difficult.

Since the emergency programs to provide employment were undertaken in 1933, the highways put under way by the state highway departments and the Bureau of Public Roads from funds under the immediate direction of the Bureau have reached more than 62,000 miles. This is equivalent to at least 12 highways across the country from north to south, and an equal number from east to west. More than 21,600 miles have been included in the construction program of the last 18 months only. Even this immense program has been too slow. It has not with sufficient rapidity absorbed the funds available for construction.

There are many causes that have delayed the beginning of work on important projects, particularly right-of-way difficulties, but I am bringing this observation into the discussion here since we have now to face the formulation of a new large program for the coming year. Highway construction, including state and federal funds, can reach above $800,000,000 if the states all meet their federal-aid apportionments. The only way that the public can be led to see its loss in the drag in state programs because of diversion of highway funds to other than road purposes is by the formulation of the timely programs that are possible if these funds are conserved and used for the purposes for which these special taxes are levied.

In our new program there is the introduction of the secondary road improvement program as a part of the permanent highway legislation. Without going fully into the approach to this important new development, two principles will be observed in the regulations which are issued—first, that the federal government will deal only through the state highway departments, and second, that the application of the funds will be upon a definite secondary road system.

Insured Mortgages Finance 20 Per Cent of Dwellings

OF THE 200,000 new dwelling units that will be built in the United States in 1936, between 40,000 and 50,000 of them will be financed under mortgages insured by the Federal Housing Administration, according to estimates based on FHA data and on the building permit figures of the Bureau of Labor Statistics. A breakdown of the FHA figures shows that 12.67 per cent of the total number of insured mortgages were on houses and lots valued between $3,000 and $4,000; that 16.61 per cent were in the $4,000-$5,000 class; that 17.48 per cent were in the $5,000-$6,000 class; that 12.15 per cent were in the $6,000-$7,000 class; and that 10.03 per cent were in the $7,000-$8,000 class. About 6 per cent of the total number of insured mortgages are on property valued under $3,000 and about 10 per cent are on property valued above $10,000.

Letters to the Editor

Salt on Concrete Pavement

Sir—We believe you are not fully informed or you would not have singled out salt in your editorial of Nov. 26 1936, entitled "End the Dispute."

We can not help but wonder why you have questioned the use of salt and have not in any way referred to calcium chloride which is damaging our highways to a very large extent when used for ice control.

Highway departments are investigating the comparative damage that might be done by using calcium chloride and salt in like manner and in the same quantities and are finding that their results seem to show that salt is the less harmful. We are keeping in close touch with the splendid research that is being done.

The Portland Cement Association is also investigating this problem and reports as follows in their circular entitled, "Concrete Information H-B-1," Nov., 1936.

There is ample evidence, both from the field and from the laboratory, that the application of *sufficient quantities* of sodium or calcium chloride to melt ice on concrete pavements results in serious scaling. The greater the concentration of these salts the greater the damage. A large quantity of the neat chemical therefore does more damage than small quantities mixed with granular material, but even the latter can be expected to cause scaling. Therefore, other available methods of treating icy pavements should be used wherever practicable, and where these chemicals are used adequate protective measures should be employed.

You will find further information in our booklet entitled, "Make Icy Pavements Safe with Rock Salt". This booklet gives the result of our investigation and, from all evidence that we have, when the use of salt is properly regulated according to our direction, concrete will not suffer any greater damage than when calcium chloride is used in the same manner.

The question then resolves itself into the advisability of treating abrasives with chemicals and, needless to say, we do not like to hear salt singled out as being the only offender. We, furthermore, want to raise the question as you did in your editorial as to the possibility of salt, in and of itself, when properly used as being an evildoer. Likewise, we want to point out the opinion of the maintenance committee of the Highway Research Board in their 1933 Report, page 336, in which they state the following: "The Committee believes that the importance of safeguarding life and property on icy pavements far outweighs the minor damage that may be done to the pavements."

I respectfully call this to your attention because of the obvious unfairness which the publicity gives to the use of salt without at the same time making mention of the competitive product which is, at present, being used in vastly greater total tonnage on the highway systems of our country. It should be no more difficult to regulate the use of salt than it is to regulate the use of calcium chloride.

C. D. LOOKER
Director of Research
International Salt Company, Inc.

Ithaca, N. Y.
Nov. 28, 1936.

Sir—Your editorial of Nov. 27, 1936 under the caption "End the Dispute" is timely. Rock salt has been used for many years in ice and snow control, especially by railroads, on station platforms and in yards and for keeping switches open. More recently the use of rock salt to remove ice from city streets and highways has been increasing due to the larger motor traffic which is now organized on a year round basis.

As a producer and seller of rock salt, we recognize that certain abuses in the nature of unwarranted wastefulness and unscientific methods of application have resulted in harmful result on the concrete, and we, therefore, attempt to educate our customers in the proper and best accepted practices.

In general we recommend the mixture of 50 to 100 lb. of rock salt to each yard of abrasive (sand or cinders) in the stock piles along the highways, and the application of the abrasives thus treated at the rate of 1½ to 2 lb. per sq. yd. of ice surface. Salt thus applied does not injure well cured, good quality concrete pavements or those made of any other material.

Where salt is used more freely in cases of emergency and when it is desired to remove large accumulations of ice, it may be used without cinders or sand by direct application to the ice, but the resulting slush should be removed as soon as the ice is loosened or melted.

Without doubt your editorial will focus attention on this subject and we hope that it will result in emphasizing the proper and intelligent use of rock salt to the end that its great usefulness may be utilized in solving the problems of safety without harmful effects on concrete structures.

FRANK L. BOLTON
President, Cayuga Rock Salt Co., Inc.

Myers, N. Y.
Dec. 3, 1936.

Sir—Referring to your editorial of Nov. 26, p. 762 on "End the Dispute" our experience in Duluth regarding the action of salt on the concrete pavements has been so definite and conclusive that I am somewhat surprised that there should be a lack of definite evidence elsewhere.

For the past ten years we have had an ordinance prohibiting the dumping of salt and salt solutions on concrete pavements. The damage done by emptying the salt solution from ice cream and soft drink freezers onto concrete pavements and by the practice of the street railway company of using salt on switches during the winter to prevent freezing is very large. When the ordinance went into effect the street railway company adopted the use of calcium chloride instead of salt with very gratifying results.

The damage to the pavement seems to result from the expansive force developed by the formation of salt crystals from the solution that has penetrated the surface of the concrete. Little layers of these crystals will be found between flakes of concrete.

The action is much more pronounced in winter than during warm weather and on new pavements than on old. Old pavements that have become saturated with crankcase oil seem to be quite immune to action.

In only one case have we experienced any trouble following the use of calcium chloride; that was in the switches of a track where the concrete had been laid late the preceding fall.

JOHN WILSON
Consulting Engineer

Duluth, Minn
Dec. 3, 1936.

Discontinuous-Web Girder

Sir—In the October 29 issue p. 622, in my analysis of the design for a discontinuous-web type of girder, two equations were incorrectly printed.

Equation (3) should read,

$$\frac{S_1 F}{4} + \frac{WF^2}{8} = M_1$$

and Equation (5) should read,

$$\frac{RF}{2h} - \frac{WF^2}{4h} = C_1$$

M. A. DRUCKER
Designer-in-Charge
Board of Transportation

New York, N. Y.
Nov. 4, 1936

Pressures on Large Conduits

Sir—Judging from the variation of soil pressures reported by other observers as existing along the extrados of large conduits under shallow fill, the pressure curve reported by D. B. Gumensky for the trial section of the Colorado River Aqueduct, in *Engineering News-Record*, Nov. 5, p. 633, appears somewhat remarkable. It is generally believed that there is an intensification of pressure over the crown of such structures, particularly for cohesive soils, due to the tendency to differential surface settlement at the crown and alongside the conduit.

It would be interesting to learn from Mr. Gumensky to what extent the cover material was compacted and to what the low crown pressure was due.

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Toronto, Ont.
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Liability for Delay

FOR ALL TOO LONG the government's contention that it is not liable for contract delays of its own making has been an unjust burden upon contractors. Recognition of the fallacy of this contention has at last come from the U. S. Court of Claims in an award for damages asked by a postoffice contractor because of the government's delay in furnishing certain plaster models. Mere extension of time is seldom adequate compensation for holding up fulfillment of a contract, though the government has heretofore regarded it as such. A contractor has a right to adhere to his progress schedule, upon which he based his estimates of cost. Disturbance of that schedule always results in a monetary loss not compensable by an extension of time. The court's award is a warning to contracting officers that delays of their fault are not to be tolerated.

Safe Roads

IN STRESSING THE FUNCTION of the driver in averting highway accidents, discussion at the annual meeting of the Association of State Highway Officials kept well within the current of accepted opinion. We hold no brief for drivers, particularly the accident habituals, but it would have been decidedly more encouraging if the road itself had not thus been given an implied clean bill of health. No engineering structure for human use is safe if, when used with prevailing human intelligence and regard for safety, it is productive of such records of death and injury as is the modern highway. To say that highways cannot be built foolproof is to say nothing. Highway engineering can never rank as good engineering until it produces trackways on which vehicles can be operated as the ordinary driver is capable of operating them without frequent accidents. Our roads today are not such highways, *and every highway engineer knows it.* Regulation is necessary, of course; road vehicle operation must be controlled; but let engineers at least not forget that highways freed of needless hazards are their first contribution to safe highways.

The Main Purpose

COSTKEEPING IS BUT A MEANS to an end. This is the essential lesson of the notable statement in this issue of the costkeeping system of the Corps of Engineers, U. S. Army. Because they must account for public funds placed in their care, records and reports form a larger part of the Engineer Corps' costkeeping methods than is usual in construction business accounting. Yet the army engineers in their function as constructors necessarily have the same objective as any private contractor —to keep daily check on accomplishment to the end of economizing in labor and materials of construction. Cost records in themselves possess some value, but the great value arises from the scientific study of these records to ascertain new ways of economizing in labor and materials. This, the fundamental reason for costkeeping, is the characteristic that lifts it out of the grade of bookkeeping to the rank of a vital aid in management engineering. In stressing this purpose the description of the army engineers' costkeeping has its chief value.

Comparative Values

TWO EVENTS THAT OCCURRED in New York City last week point a valuable lesson in public-works development. These were the opening of the Henry Hudson Parkway and the holing through of one of the sewer tunnels that will connect the Bronx with the new Wards Island treatment plant. Both events are highly significant to the city's future, but the daily newspapers, quite properly from their standpoint, treated the parkway opening as the more important. Parkways can be seen and personally used, whereas sewer tunnels are out of sight and have much less obvious public importance. Parkways and bridges also lend themselves to pictorial description better than do tunnels. Hence a new parkway is a bigger news event than a new tunnel. In this bit of newspaper reasoning is reflected the public psychology that determines how the public-works dollar is spent. The public demands better roads, but it is relatively passive to sewage plants, with the result that such community facilities have lagged behind needs. The actual comparative rating of the Henry Hudson Parkway, which relieves one of the worst traffic bottlenecks in the city, and of the Bronx sewer tunnel, which helps to clear up one of the dirtiest streams in the country, cannot readily be determined and is in fact rather unimportant. What is important is the relative evaluation that the public places on them, and the verdict unquestionably favors the parkway.

The Construction Dollar

THE SIGNIFICANCE of the Labor Department's study of the indirect effect of each dollar spent by the Public Works Administration goes far beyond current questions as to how best to spend relief money; the study will be of permanent value to the construction industry. For the first time that industry is provided with a yardstick by which its full contribution to the general prosperity of the country can be measured. The long study of the Bureau of Labor Statistics (*ENR* Dec. 10, p. 838) shows that for every dollar spent directly on PWA projects there was created 2½ dollars worth of work in industries and transportation agencies supplying materials for the job. This was found in the directly underlying operations. Obviously, the remoter effect of the turnover of the money is still more extensive. As these operations covered almost the full range of construction activities the findings are applicable to the construction industry generally. Such a study has been needed for a long time. It would have been of inestimable value had its results been available in 1930, when so much thought was being given to means for checking the business decline. Many men of the construction industry believed that the almost complete cessation of construction was of major significance far beyond those directly affected, but they had no figures to prove that it did. It was because of that belief that this journal among others argued so strongly for spending emergency funds on the

construction of public works. The Labor Department's study shows that the effect was even greater than was believed at that time. It adds new importance to the position held by construction in the national economy.

Work Ahead

WELL INFORMED ESTIMATES forecast a car registration exceeding 28 million next year, an all-time high. It needs no more than this figure, coupled with present road experiences, to tell us that road traffic is growing to prodigious dimensions. And no end to the growth is yet in sight. What must be done to enable the roads to take care of it?

Thomas H. MacDonald, federal road chief, last week answered the question in addressing the American Association of State Highway Officials. His remarks presage a thorough-going reorientation of our national road planning and building. If an efficient trackage system is to be provided for the volume of road traffic that demands accommodation, there is new work ahead —much and difficult work. Main items of this new works are to break adequate pathways through the dense congestion around our cities, and to build a national system of express roads to form the main traffic trunks that we now lack. Together with this new work, however, we must continue the half-done job of getting our large mileage of byroads out of the mud.

Safety, capacity and reduction of delays are at issue. The new work is going to determine whether our road system will be made an efficient agency of transport or a costly makeshift; whether dangerous and intolerable traffic conditions will prevail, or convenient, rapid and pleasant travel. The changing road requirements are by no means the concern of road people alone, for all circles of business and public are affected. The blocked condition of cities cuts down their efficiency and increases their cost level; the absence of adequate trunk routes makes transport costly and inconvenient.

European experience in road planning is instructive in this connection. Because the Continent had an ancient developed road system and because public policy repressed motor road growth, it had in the main no road-improvement problem comparable to ours. Largely for this reason some of its states are in a position to take up the real road problems of today. Hence the interesting development of city belt and radial arteries and national express trunks segregated from the normal road system. Europe is building these facilities for the traffic of tomorrow; we need them even more urgently, to take care of the traffic that is already here.

While the need for city gateways and cross-country trunklines has been staring the road planer in the face for nearly a decade, it had to be disregarded until now in order to permit carrying on the big job begun 20 years ago by the federal-aid law—systematic improvement of our vast network of primitive roads. Nevertheless a number of cities made a start on breaking through the ring that was throttling them, and some states began to plan express routes. But no concerted, systematic attack on the problem was attempted. Hence we now get neither the full transportation value nor the full social value out of motor car and road.

Difficult planning problems are involved. The planning of city gateways is mainly a local problem, or rather a regional one, since it requires the interests of the city's entire tributary area to be considered. On the other hand the planning of trans-country trunk routes is a national problem, though with important state considerations. Many new routes may be found necessary, as the conditions that governed road location in pioneer days are no longer valid controls.

When one considers the full scope of the prospect outlined by Mr. MacDonald and remembers that improvement of country roads must also go on, the vast volume of work that lies ahead becomes apparent. Laying out a plan for carrying this work forward on all fronts, rapidly enough to meet traffic demands effectively and yet within the bounds of financial and economic feasibility, is an undertaking worthy of the best engineering skill and administrative genius.

Signs of Progress

IT IS WITHIN the daily experience of engineers that the condition of industry has its effect on the general well-being. For this reason the profession will welcome the outcome of the two industrial gatherings of the last week—the conference called by the official Coordinator of Industrial Cooperation, Major George L. Berry, and the convention of the National Association of Manufacturers. The conclusions of both gatherings indicated that progress is being made in those industrial problems that center on fair competition and labor relations. These are intensely important problems, for when (if ever) they are solved, we will be rid of many serious troubles. Strikes and monopoly charges are uncomfortably prevalent.

The manufacturers declared in effect that they are willing and anxious to cooperate with the government in dealing with industrial difficulties and maladjustments. Only a year ago they were determined not to cooperate, and did not hesitate to say so. The Berry conference declared that industrial management and labor are ready to cooperate with each other and with the government, which also is in contrast to what the same group did a year ago. True, cooperation is an empty word until it is translated into action; nevertheless if the will is there a way usually can be found.

Whether anything workable and useful will come out of the reported plan of the Berry group to set up a new NRA, or whether the manufacturers' ideas can be made effective, is purely speculative at present. The important fact is that, if the will to cooperate carries through, there is a real possibility that something can be done to keep the industrial machine from getting out of adjustment and slowing to a stop.

Yet the real problem lies beyond. That, as Harold G. Moulton re-emphasized in addressing the manufacturers, is the problem of building up production so that there will be more to go around than the present $2,000 or so per family. The nation will not use all the kinds of things it can make until it produces a substantially larger amount per family. And this of course is possible only through more efficient production, which is the engineer's responsibility.

CURRENT NEWS

New Trial Ordered In Duke Power Suit

U. S. Supreme Court declares lower court procedure was improper and orders a retrial of the case in the lower court

The U. S. Supreme Court on Dec. 14 sent the Duke power case back to the lower courts for retrial without expressing an opinion on the intrinsic merits of the case. The court held that the case, which involves the right of the PWA to make loans and grants to municipalities for construction of power plants competing with private utilities, "presents irregularities in practices which we think should not be overlooked."

The Duke power case is an attempt by the Duke Power Co. and the Southern Public Utility Co. to set aside a $2,852,000 loan and grant to Greenwood County in South Carolina for construction of the Buzzard's Roost hydro-electric plant on the Saluda River which would provide power for Greenwood and adjoining counties. The federal district court for western South Carolina granted an injunction against the loan and grant, but the fourth circuit court of appeals reversed the lower court last February, and the case was appealed to the Supreme Court.

Fifty-one similar PWA allotments, involving about $50,090,000 are now pending in the courts awaiting a decision on the Duke case.

The present decision of the court arises from the fact that, after the first injunction had been granted against PWA, the PWA entered into a new and different contract with Greenwood County. At that time the court of appeals remanded the case to the lower court for further consideration on amended pleading. The Supreme Court now holds that this action was improper and that the decision of the lower court should have been vacated and an entirely new suit should have been started.

Bids Opened for Iron Lining On Second Midtown Tubes

The Port of New York Authority, on Dec. 8, opened bids for tunnel lining for the twin, north, tube of the new Midtown Hudson tunnel. The Bethlehem Steel Co. of Bethlehem, Pa., was low with a bid of $3,080,000, followed by the United States Pipe & Foundry Co. of Burlington, N. J., with $3,134,000. The high bid was that of the Koppers Co. of Baltimore for $3,288,000.

The program of the Port Authority calls for a contract within 90 days for building the underwater section of the twin tube by the shield method under compressed air. The successful bidder for the lining, therefore, must be ready to start shipping the cast iron and cast steel segments by April 15. The lining will be built in rings 30 in. wide made up of fourteen segments and a key segment. The outside diameter of the tunnel will be 31 ft. About 50,000 tons of material are involved in the pending contract.

Court Recompenses Contractor For Government Delays

A far-reaching decision was handed down by the United States Court of Claims in Washington, D. C., on Dec. 7 awarding judgment in the sum of $14,286 to the Karno-Smith Co. for damages suffered in the construction of the United States post office and courthouse at Trenton, N. J.

The court determined that the contractor was seriously obstructed in the orderly prosecution of the work by government delays. The principal default of the government was due to its unreasonable delay in furnishing certain plaster models needed in the manufacture of the ornamental terra cotta for the exterior front and two sides of the building.

The court held that "the mere fact that the government had granted an extension of time for the completion of the contract, due to the fact that it had delayed the plaintiff, does not relieve it of the responsibility for the damages incurred by the plaintiff due to these delays."

The court recognized in this decision that a contractor has a right to adhere to his progress schedule.

New York City Sewer Tunnel Holed Through

The mile-long 15-ft. diameter sewer tunnel driven through rock to connect the Bronx to the $28,000,000 Ward's Island sewage disposal plant was holed through on Dec. 8.

Work on the tunnel was started in September, 1935, from two headings, one at Ward's Island and the other at 133d St. in the Bronx. The tunnel runs under the Bronx Kills, Randalls Island, Little Hell Gate, and about half of Ward's Island.

The tunnel will be lined with concrete, reducing the net inside diameter to 10.5 ft. It will have a capacity of 400 m.g.d. The tunnel connects with the Bronx intercepting sewer, which serves the area between East 133d St. and Jerome Ave. It will handle sewage which now is released into the East River.

The George H. Flinn Construction Co. is carrying out the work under a contract from the sanitation department of New York City. Its low combination bid of $2,354,000 included, in addition to the present tunnel, a tunnel from Manhattan under the East River and shafts and substructures for grit chambers at 110th St. and the East Side drive in Manhattan and at 133d St. and St. Anne's Ave. in the Bronx.

Injunction Granted Against TVA

U. S. District Court grants temporary injunction against expansion of TVA pending settlement of suit

A temporary injunction was granted on Dec. 14 by the federal district court at Nashville, Tenn., against further expansion of the power facilities of the Tennessee Valley Authority until a decision is reached in the case brought by nineteen utility companies attacking the constitutionality of the activities of the TVA.

About 35 projects embracing transmission lines, substations, and distribution systems now under construction, were exempted from the effect of the injunction. Neither will the injunction interfere with the construction of dams, or the continuation of electric service to consumers now receiving TVA power. Among the exempted facilities are heavy duty transmission lines connecting Wilson Dam, Pickwick Dam, and Memphis; Norris Dam and Alcoa; and Chickamauga, Guntersville Dam and Pickwick Dam.

The effect of the injunction is to prevent expansions and extensions of TVA activities except on the projects specifically exempted and to restrain the TVA from "soliciting present or potential customers of complainants." It will remain in force until the court orders otherwise or until trial of the power company's suit against the TVA. The suit is set for next March 8.

The court explained that the order would not interfere with TVA operations in the territory ceded to it in a contract between the TVA and the Commonwealth & Southern Corp. Nor would it prevent additional customers from "tying onto rural lines now being erected and being used by rural electric membership corporations."

Yale Appoints Hardy Cross To Head Civil Engineering

Hardy Cross, for the past 15 years professor of structural engineering at the University of Illinois, has been appointed professor of civil engineering at Yale University and chairman of the department of civil engineering. The chair of civil engineering at Yale, established in 1852, is one of the oldest professorships of civil engineering in the country. The appointment takes effect next fall.

Professor Cross, the author of numerous books and papers on civil engineering subjects, is particularly known for his development of the fixed end moment distribution method of analysis of rigid frames. He is a graduate of Hampden-Sydney College and the Massachusetts Institute of Technology. In 1911 he received the degree of master of science in civil engineering from Harvard and in 1934 the honorary

BUFFALO HOUSING PROJECT TAKES SHAPE

The Kenfield housing project at Buffalo, N. Y., comprising a total of 78 buildings, divided into 658 apartments of three, four and five rooms and covering a 65-acre site, is now 36 per cent completed. The substructures are finished, and the superstructure is 33 per cent completed. The buildings in the $4,509,000 PWA project are all of the hollow tile, brick veneer type, with concrete floors, reinforced concrete joints, partition tiles, metal window and sash, and flat reinforced asphalt roofing.

The ground was purchased at a cost of 10 cents a square foot, or $285,000 in all. The foundation work, costing $174,000, was done by John W. Cowper, Inc., while the general contract for the superstructure is held by the Fleischer Engineering & Construction Co. and Joseph A. Bass, and involves $4,050,000.

The group of buildings include 122 three-room apartments, 290 four-room apartments; and 246 five-room apartments which will rent, according to present plans, at from $5 to $7 per room. No tenant will be accepted whose income exceeds five times his rent.

Each housing unit is built around an open court. One of the features is a central heating plant which will provide regulated heat and hot water. Each of the apartments will have an electric refrigerator and there will be garage accommodations provided. The large building at the top of the airview is the new Kensington high school.

Chester Oakley of Buffalo was the architect for the group of buildings. All of the work is under the supervision of George F. Fisk, who is district manager of the housing division, PWA, for the Buffalo district.

(*Continued from page* 874)

degree of doctor of science from Hampden-Sydney. After some years of railroad engineering experience, he served for seven years on the faculty of Brown University. Three years of general structural engineering practice were followed by his appointment to the University of Illinois in 1921, where he has held a professorship until this time.

Professor Cross will be director of graduate studies for the department and will supervise the work of advanced students in civil engineering, particularly in the field of structural engineering. In addition to his graduate instruction he also will teach courses for undergraduate students in structural design.

Cities Favor Municipal Power

Out of 140 towns and communities which have voted whether or not to ask for or accept PWA loans to build municipal power and light systems, 115 have voted favorably. Some of these cases involve competition with established services and others involve the construction of new systems where none existed before.

Type of Treatment In Buffalo Decided

Greeley and Hanson recommend partial digestion followed by incineration—pumping plant contract let

Greeley & Hanson, engineers for the $15,000,000 sewer and sewage disposal project in Buffalo, N. Y., have recommended partial digestion of sludge followed by incineration to the Buffalo Sewer Authority as the method of disposal to be used in the $3,800,000 disposal plant to be erected on Bird Island. The engineers report that the cost of such a system will be $885,000 with an estimated annual cost, including operating expenses and fixed charges, of $113,000. They state that although the construction cost of a complete digestion system would be $105,000 less, the annual expenditures for such a system would be $8,130 more than for the recommended system.

The recommended plans include provision for storage of sludge gas to be used to heat the digestion tanks and to fire the incinerators.

Contracts for the construction of a pumping station, grit chamber and four sedimentation tanks were awarded on Dec. 9 to the Bryant & Detwiler Co. of Detroit, Mich., on its low combination bid of $1,714,000. The sewer authority, on recommendation of the engineers, withheld action on three proposed contracts for construction of the principal buildings for the disposal plant because the total low bid, amounting to $2,203,000, exceeded the engineer's estimate of $1,934,000. The excess of the bids over the estimate was attributed unofficially to rising costs of material and labor since the time the plans and specifications were drawn.

Bryant & Detwiler are expected to begin work on their contract soon.

Mexico to Stop Hiring Foreign Engineers

Beginning next year only Mexicans will be employed on hydro-electric and irrigation work performed by the Mexican government. At that time all foreigners will be replaced by natives. Most of the few foreigners now employed are technicians. In the past, the government has had to depend upon foreign engineering and technical assistance for such construction work, but there is now a sufficient number of Mexican engineers.

New York Opens Two Parkways

Henry Hudson parkway in the Bronx and the Shore Drive in Brooklyn may eventually be parts of a single express drive

Traffic was admitted on Dec. 12 to two new parkways in New York City, one located at the northern boundary of the city, the Henry Hudson Parkway, the other at the southern extremity, the Shore Drive in Brooklyn. Although now separated by 25 miles of the most intensively developed property in the world, the two new parkways will be linked into a single express road should the proposed Battery-Hamilton Ave. tunnel under the harbor be built. Such a road would cross the Bronx on the new Henry Hudson parkway, traverse the length of Manhattan Island along the Hudson River waterfront, cross under the harbor to Brooklyn, and follow the Shore Drive around Brooklyn to a connection with the Long Island highways at Southern State Parkway.

The new Shore Drive, located in front of Fort Hamilton, is about a mile long, constructed on a 750,000-cu. yd. hydraulic fill behind a new retaining wall. The drive consists of two 33-ft. roadways separated by a landscaped strip of varying width. It was built by the state department of public works.

Henry Hudson Parkway, connecting the north end of Riverside Drive in Manhattan with the Westchester County parkways, is 4½ mi. long, mostly in the Bronx, and crosses the Harlem River on an 800-ft. hingeless steel arch (*ENR*, Aug. 13 and Nov. 12, 1936). It serves to relieve one of the worst traffic bottlenecks in the city, the bridge at Broadway and 225th St. which is used by all traffic entering or leaving the west side of Manhattan Island.

The south half of the parkway was built by the Henry Hudson Parkway Authority, and a toll of 10 cents per vehicle will be charged. The north half was built by the state department of public works. A total of 13 grade separation structures are used on the route, which provides two 32-ft. separated roadways north of the river and a 40-ft. roadway on the bridge and south of the river. The Henry Hudson Parkway will be described in more detail in next week's issue.

Aerial Explorations Photo

KANSAS CITY REPLACES ITS OLD PUBLIC BUILDINGS WITH MODERN STRUCTURES

Building work in Kansas City, Mo., fared better during the depression than in most cities because of an ambitious public building program launched, as part of a 10-year plan of improvement, before municipal credit dried up. Three imposing structures have appeared on the Kansas City skyline in the past two years—a new Jackson County court house, a new city hall, and a new municipal auditorium. All of these buildings are shown in this air view in their current state of completion.

In the left foreground is the auditorium, a huge structure 425x330 ft. in plan containing a 14,000-seat arena and a 3000-seat theatre. Across the street the old convention hall is being dismantled after having given a quarter of a century of service.

The city hall and the court house are skyscraper type structures far removed from their predecessors and occupying a two-block site at the right of the view. The 32-story city hall skeleton is being enclosed while the courthouse just to the right is now completed and occupied. Foundation excavation for all these buildings was by relief labor, much of it manually, while the actual building of the foundations and superstructure was let by contract.

Los Angeles Voters Approve Electric Plant Purchase

Purchase of the electric properties of the Los Angeles Gas & Electric Corp. by the Los Angeles, Calif., department of water and power at a price of $26,340,000 was authorized by Los Angeles voters at a special election Dec. 8 with a vote of 91,000 to 44,000. The charter amendment authorized the board of water and power commissioners to borrow the $26,340,000 with which to buy the property. It is expected the commission will issue revenue bonds against the earnings of the bureau of power and light.

The amendment also set up a procedure by which three gas companies in the region may obtain 350-yr. gas franchises from the city.

Weak Shale Foundation Caused Dam Failure

A report now being prepared by the Harza Engineering Co. on the causes of the failure, on Sept. 24, of a small dam on the Niobrara River near Spencer, Nebr. (*ENR*, Oct. 8, 1936, p. 526) indicates that the failure arose from the fact that the dam was founded on a shale so weak as to be hardly more than a mud rock.

The report states that "since the time of failure, 14 core borings have been made in the foundation material upon which the dam was built. These borings indicate a soft black shale with occasional white streaks of bentonite. The Pierre shale is in an early stage of consolidation, containing a moisture content of about 37.5 per cent. The cores can be readily broken in the fingers, indicating weak material. Under continually moist conditions the surface of the material becomes very slippery with low frictional resistance. The material cuts easily with a knife and looks and feels, when dry, like a black wax."

Mr. Harza is of the opinion that the failure was not due merely to sliding or shearing of the foundation. The foundation material, he states, is so very weak that the slightest yielding of the foundation, causing the loss of perfect contact between the dam and the shale, could have opened a fine seam between the concrete and the shale and permitted water pressure to enter, causing uplift which would have tended to float the structure and weaken its sliding resistance.

Studies are now being made to determine whether the dam can be redesigned so as to be safe under the existing conditions.

The Spencer dam was built in 1926 and has been operated by the Northern Nebraska Power Co. It is an earth dike, 1,800 ft. long and about 18 ft. high, with a 400-ft. concrete spillway section. The spillway section failed suddenly as a unit.

Flow of Mississippi River Sets Record Low

On Dec. 10 the Mississippi River at Rock Island, Ill., set a new all-time low for total discharge, with a flow of 9,000 sec.-ft. The previous low figure was 10,000 sec.-ft. established in 1934. The average flow at Rock Island is 25,500 sec.-ft. On Aug. 14 of this year the river reached an all-time low for the navigation season at Rock Island when the river stage was —1.0 ft.

Contractor Refused Payment Under Illegal Contracts

Assistant Attorney General Jones of Kentucky, on Dec. 8, advised the state commissioner of highways not to pay the Codell Construction Co. of Winchester, Ky., for work they have done on two road projects in Pikes County on which the contracts were awarded illegally.

Both of the road projects have been completed. They involve construction of about 2.5 miles of the Kentucky-Virginia state line road at a cost of $45,519.

The company, according to Mr. Jones, received a valid contract from the highway commission last year and through supplemental agreement on the original contract continued work on the two additional projects. Since no competitive bids were received on the two additional projects, as is required by law, and since the contractor entered into the contract at his own risk and peril, Mr. Jones held that the supplemental agreements were not binding.

SOCIETY CALENDAR

ASSOCIATED EQUIPMENT DISTRIBUTORS, annual meeting, New Orleans, La., Jan. 10-12.

CANADIAN CONSTRUCTION ASSOCIATION, annual convention, Ottawa, Canada, Jan. 11-13.

AMERICAN ROAD BUILDERS ASSOCIATION, convention and highway exhibit, New Orleans, La., Jan. 11-15.

UNIVERSITY OF COLORADO, highway engineering conference, Boulder, Colo., Jan. 14-15.

AMERICAN ENGINEERING COUNCIL, annual assembly, Washington, D. C., Jan. 14-16.

AMERICAN INSTITUTE OF CONSULTING ENGINEERS, annual dinner meeting, New York, N. Y., Jan. 18.

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual meeting, New York City, Jan. 20-23.

ENGINEERING INSTITUTE OF CANADA, annual meeting, Montreal, Canada, Jan. 29-30.

AMERICAN CONCRETE INSTITUTE, annual meeting, New York, N. Y., Feb. 23-25.

COLORADO SOCIETY OF ENGINEERS, annual meeting, Denver, Colo., Jan. 15-16.

LOUISIANA ENGINEERING SOCIETY, annual meeting, New Orleans, La., Jan. 22-23.

NEW YORK STATE SEWAGE WORKS ASSOCIATION, annual meeting, New York City, Jan. 21-23.

AMERICAN WOOD PRESERVERS ASSOCIATION, annual meeting, New Orleans, La., Jan. 26-28.

NATIONAL PAVING BRICK ASSOCIATION, annual meeting, Detroit, Mich., Jan. 1-29.

CONNECTICUT SOCIETY OF CIVIL ENGINEERS, annual meeting, New Haven, Conn., Feb. 16-17.

SOUTHWEST ROAD SHOW AND SCHOOL, Wichita, Kansas, Feb. 23-26.

ASSOCIATION OF HIGHWAY OFFICIALS OF NORTH ATLANTIC STATES, annual convention, New York, N. Y., Feb. 24-26.

MINNESOTA FEDERATION OF ARCHITECTURAL AND ENGINEERING SOCIETIES, annual convention, St. Paul, Minn., Feb. 26-27.

LICENSE EXAMINATIONS

MICHIGAN, examination for architects will be held at the University of Michigan and for engineers and surveyors at the University of Michigan, at Michigan State College, at Michigan College of Mines, and at Ironwood, on Dec. 28-30.

Contractor Prequalification Required by World's Fair

The New York World's Fair Corporation has announced that it will let all contracts on the basis of competitive bids and that any individual or corporation who desires to bid on any construction work must be prequalified before its bid can be considered.

The corporation has prepared prequalification forms for prospective bidders which will be mailed to anyone who requests them from the corporation at its address in the Empire State Building, New York.

Height of Alamogordo Dam Raised Seven Feet

Secretary Ickes has approved a change in the plans for the Alamogordo Dam of the Carlsbad federal reclamation project to increase its height by 7 ft., bringing the height to 142 ft. The dam is now under construction on the Pecos River near Fort Sumner, N. M. The increased height of the dam will provide a reservoir capacity of 157,000 acre-ft., an increase of 43,000 acre-ft. over the original plan.

Alamogordo Dam, an earth and rock fill structure, is being built by the Hallett Construction Co. of Crosby, Minn., under a contract with the Bureau of Reclamation. The original contract called for payment to the contractor of $1,133,000. Under the change order the amount of the contract will be increased $175,000.

The change in plan was made in order to increase the length of time which will pass before silting will begin to interfere with the storage needed for irrigation; this period, it is estimated, has now been increased from 25 to 45 years. It is intended, in 20 or 25 years, to install three radial gates in the spillway when silting makes necessary the additional capacity which can be gained in this fashion. The original plan called for immediate installation of the spillway gates.

Sales Tax on Utility Upheld by Court

The New York City 3 per cent sales tax imposed on utilities for the relief of unemployment was held constitutional on November 30 by the United States Circuit Court of Appeals, when it dismissed the suit filed by the Southern Boulevard Ry.

The railroad company, which operates a surface line in the borough of the Bronx, claimed that the tax, which was imposed by the city in 1935 under an enabling act passed by the New York State Legislature in 1934, was unconstitutional and sought the recovery of $8,800 paid on its gross income for the first nine months of 1935.

The Court's decision stated: "The inability of the applicant to shift the tax to the public because of the five-cent fare compelled by franchise, does not render the tax unconstitutional. This is a hardship caused by its contract.

"During the period for which the taxes now sought to be recovered were paid, appellant suffered a deficit, but this fact . . . cannot affect the constitutionality of the tax or justify an interference."

Washington Highlights

By Paul Wooton

The Virginia Railway has petitioned the Interstate Commerce Commission for permission to construct 30 miles of new line in Wyoming county, W. Va., to provide an outlet for coal and timber in an area now without railroad facilities.

Many plans for flood control projects included in the 1936 omnibus authorization bill are being received from the field by the War Department, and the response of local interests in providing the necessary land is exceeding expectations. By the time the next Congress convenes it is anticipated that a program of some size will be ready for submission, so that appropriations may be made to permit immediate construction.

One of the first bills on which Congress is likely to act in the forthcoming session is a measure to provide for the operation of Bonneville Dam and to establish the conditions under which power may be sold. It is expected that the bill will provide for operation by the Corps of Engineers with the Federal Power Commission approving contracts and rates. The commission has made an extended study so as to be able to prescribe a schedule of wholesale rates.

Approval of the St. Lawrence waterway project was again voiced by President Roosevelt in a letter to the Champlain Valley Association, dated Nov. 16 but only now made public, in which he stated that he will press for action as soon as possible on the St. Lawrence waterway treaty. The President also expressed the hope that advocates of the waterway would continue their activities so as to strengthen the demand for action.

A large loan recently granted by PWA to a privately owned electric power concern in Wisconsin is believed by the power division director's office to be the first PWA loan to a private utility. The loan, however, was not accepted, since after it had been granted the utility was able to obtain a private loan. Many applications for loans have been made by private power companies, but previously all have been rejected because of the unsound condition of the applicants.

Navy Rejects the Only One Bid On Pearl Harbor Drydock

The Bethlehem Shipbuilding Corporation of New York City was the only bidder on the construction of the Navy's new floating drydock for Pearl Harbor, Hawaii. The Navy rejected the bid. The Bethlehem company offered six alternate bids ranging from $16,604,000 to $21,312,000 based on furnishing varying amounts of auxiliary equipment.

The drydock, of about 45,000 tons displacement, will be 1,016 ft. long, 165 ft. wide, and 75 ft. high from the top deck to the keel. It will be entirely in one piece, and will have a pointed bow, steering mechanism and a stern gate which can be raised and lowered. It will be large enough to accommodate any present naval vessel.

Road Bureau Work Summarized In Departmental Report

About 13,790 miles of roads and streets were completed during the fiscal year ending June 30, 1936, under the cooperative work of state and federal agencies, according to the report just issued by Secretary Wallace of the Department of Agriculture. A large part of the road construction activity of the department centers in the administration of funds granted the states for unemployment relief through highway and grade crossing construction.

Of the above total 7,355 miles were on the federal-aid highway system outside of cities, 755 miles on city extensions of the federal-aid system, and 5,679 miles on feeder and secondary roads. In addition to this work, the department also completed improvements on 22 miles of flood damaged roads, 236 miles of forest highways, 436 miles through other public lands, 5,684 miles of forest roads, and 1,965 miles of forest trails.

At the end of the year the department's program involved a total of 25,812 miles of all classes of road construction.

The federal Bureau of Public Roads attacked grade crossing elimination on a large scale during the last fiscal year. Three hundred grade crossings were eliminated, either by building of structures or by relocation of highways; 10 existing structures were rebuilt; and protective devices were installed at 185 crossings.

In addition, the department had under contract or approved 1,466 grade crossing eliminations and 813 crossing protection projects which will be completed by the end of the year.

Nearly 7,000 grade crossings have been eliminated with the assistance of the federal government since 1916, and a total of about 2,000 are to be eliminated under the present $200,000,000 program.

The report, which covered all the activities of the Department of Agriculture, urged continuing effort under a definite policy to combat recurrent drought effects and to develop a Great Plains economy. Secretary Wallace points out that such a program should aim at arresting excessive soil erosion and conserving water, both of which involve engineering problems. In addition to contour plowing, lifting, terracing, and other soil conserving work, dams will be needed to check water erosion and hold water for dry periods.

Brief News

INSTALLATION OF THE SECOND 82,500 kw. generator at Boulder Dam has been completed, and the unit is now undergoing final test before going into service.

SIXTY-FIVE NEW POSITIONS in the engineering department of the city of Seattle have been created for 1937. The new personnel includes two assistant engineers, four junior engineers, three structural designers, eight structural draftsmen, seven draftsmen, and one superintendent of construction.

PLANS FOR DEVELOPMENT of water power in northern Korea are well under way. A license has been granted to the Choshinko Hydroelectric Power Co. to develop 400,000 kw. on the Choshinko River. The Japan Electric Industrial Co. plans to develop 200,000 kw. on the Oryokko River, and the Oriental Colonization Co. is planning to develop the Zumanko River.

THE BUFFALO PUBLIC WORKS DEPARTMENT has submitted a five-year program of capital expenditures totaling about $13,500,000 to the municipal budget director. The largest item in the program is $10,271,000 for storm water drains throughout the city. Other projects are a $500,000 bridge in South Michigan Ave. over the city ship canal; a $1,000,000 drain enclosure project; and additions to bridge facilities totaling $902,000.

A RAILROAD AND HIGHWAY BRIDGE across the Dvina river in Latvia, has recently been completed at Krustpils, halfway between Riga and the Russian frontier. The bridge, which is 900 ft. long and contains about 1,000 tons of high tensile steel, was built by Braithwaite & Company, of Birmingham, England. The bridge was badly needed inasmuch as, although there are three bridges across the Dvina at Riga and two at Daugavpils, in the 150-mile distance between those cities there are only two bridges across the river.

SURVEYS OF THE OHIO RIVER will be continued with an allotment of $100,000 approved on December 3 by the War Department. This allotment is from the regular river and harbor appropriation and arises from a provision of the river and harbors act of 1935 which provides for supplementing the river basin surveys authorized by the 1927 act in cases where changes in conditions have occurred since the completion of those earlier surveys. The new investigations are now in progress, and the present allotment is required for their completion.

A MATHEMATICAL MACHINE capable of solving nine simultaneous linear algebraic equations in nine unknowns has been developed at the Massachusetts Institute of Technology by John B. Wilbur of the department of civil engineering. The calculator, which weighs 2,000 lb. and has more than 13,000 parts, has been developed during the past two years for use in the solution of problems arising in the design of structures. The machine may be applied to problems involving more than nine unknowns by the use of a method of successive solutions.

THE PWA HAS MADE a grant of $1,270,800 to the school district of Philadelphia, Pa., for the construction of two schools with a total estimated cost of $2,824,000. The larger of the projects calls for a grant of $1,001,700 for the construction of a senior high school building estimated to cost $2,226,000. This will be a three-story and basement fireproof structure with auditorium and gymnasium; improvement of the grounds is also included in the project. The smaller project, estimated to cost $598,000, is being aided by a grant of $269,100. It will be a three-story and basement fireproof L-shaped school with an auditorium. These buildings are part of a major project which includes an elementary school estimated to cost $684,500, for which a Public Works Administration grant of $308,000 was made in October and an elementary school estimated to cost $621,000, which received a PWA grant of $279,400 at the same time.

Personals

W. N. BROWN, who has been with the U. S. Department of Agriculture for the past six months in charge of the use of aerial photography for crop acreage studies for the A.A.A., has returned to private work with W. N. Brown, Inc., of Washington, D. C.

MAX W. KING has resigned his work for the Lower Colorado River Authority on the Buchanan Dam, and has become construction superintendent for the Mexican Irrigation Commission on the construction of El Azucar Dam on the San Juan River in the state of Tamaulipas.

WILLARD T. CHEVALIER, vice president of the McGraw-Hill Publishing Co., has been appointed by the Secretary of State as a representative of the United States on the Permanent International Commission of the Permanent International Association of Road Congresses. Mr. Chevalier is president of the American Road Builders' Association.

A. M. KIRKPATRICK has been appointed chief district engineer for the Province of Prince Edward Island by the Canadian Department of Public Works, succeeding the late W. E. Hyneman. Mr. Kirkpatrick, who has been in the Dominion engineering department for the past 25 years, had been serving as senior assistant engineer in the Winnipeg district office for the provinces of Manitoba, Alberta and Saskatchewan.

D. W. MCLACHLIN has been appointed engineer in charge of design and capital construction for the Canadian Department of Transportation. GUY A. LINDSAY has been appointed engineer in charge of general engineering for the same agency. Mr. McLachlin was formerly engineer in charge at the Hudson Bay Terminal, and Mr. Lindsay was designing engineer on ship canal construction.

RAY CROW, Alabama administrator for the WPA, has resigned, effective Dec. 15, and will return to the engineering department of the Tennessee Coal, Iron & Railroad Co. For the past several years Mr. Crow has been connected with the WPA on leave of absence from the Tennessee Coal, Iron & Railroad Co. A. P. MORGAN, JR., will succeed Mr. Crow as Alabama administrator for the WPA. A. J. HAWKINS, chief engineer for the state WPA, will become deputy administrator.

MACE H. BELL has been appointed district engineer for the American Institute of Steel Construction to cover the southwestern territory with headquarters at New Orleans. Mr. Bell was formerly assistant engineer for the U. S. Engineers on design and construction of dams on the Muskingum Conservatory project. ROBERT J. WOOD, who formerly covered the southwestern territory for the Institute, has resigned to go with the Mississippi Valley Structural Steel Co.

STANLEY A. TEMPLE, who has been supervisor of maintenance of way of the Toledo division of the Baltimore & Ohio R. R., has been appointed industrial engineer at Baltimore. Except during two two-year furloughs, Mr. Temple has been connected with the Baltimore & Ohio since his appointment as assistant engineer in 1920. In the past he has been connected with the

operating departments of the Chesapeake & Ohio, Pittsburgh & West Virginia, and San Antonio & Arkansas Pass railroads.

C. M. OSBORN, chief engineer in Illinois for the PWA, has resigned to become city manager of Kenilworth, Ill. In the past Mr. Osborn has served as city manager of East Cleveland, Ohio; Kenosha and Shorewood, Wis; and Wilmette, Ill.

W. J. McMILLAN has been appointed Washington manager of the Portland Cement Association, succeeding MARK BEEMAN, who is retiring. Mr. McMillan has been associate manager of the Washington office for the past three years, and for the preceding five years he served as regional structural engineer in the Middle West for the association. He is a graduate of Iowa State College and has served as an engineer with the Illinois highway department and the Chicago Sanitary District.

Obituary

GEORGE KERR, for 40 years a road contractor in British Columbia, died on Dec. 3 in Vancouver at the age of 70.

MICHAEL SULLIVAN, a dredging contractor who had been active for many years on the Great Lakes, died on Dec. 5 in Detroit at the age of 87.

THURSTON C. CULVER, a civil engineer connected with the real estate firm of Pease & Elliman and formerly an engineer for the department of water supply, gas & electricity of New York City, died on Dec. 9 in New York City, aged 70. Mr. Culver was for several years an engineer with the old New York City department of public works and was connected with the field engineering for the Croton water works.

CONSTRUCTION STATISTICS FOR THE WEEK

ENGINEERING construction awards drop back to $39,853,000 after three high weeks. This total compares with $59,244,000 a week ago and $86,817,000 a year ago. It is made up of private, $22,767,000; public, $17,086,000; federal, $1,466,000 and state and municipal, $15,620,000. Corresponding values for a week ago are: total, $59,244,000; private, $28,863,000; public, $30,381,000; federal, $12,567,000; state and municipal, $17,814,000. A year ago the volume corresponding to this week's values was: total, $86,817,000; private, $5,700,000; public, $81,117,000; federal, $34,580,000; state and municipal, $46,537,000. This high value for last year was due to the PWA setting Dec. 15 as a "dead line" for making contract awards and to the start of work on a TVA dam.

Sewerage awards and commercial buildings show gains this week. The classified subtotals are: industrial buildings, $1,642,000; commercial buildings, $9,699,000; public buildings, $2,619,000; highways, $4,629,000; bridges, $1,641,000; sewerage, $3,733,000; waterworks, $1,494,000; earthwork, drainage, $1,441,000; unclassified, $12,955,000.

The larger projects for the week include:

Store building, J. Shillito Co., Cincinnati, Ohio	$900,000
Office building, Southern New England Telephone Co., New Haven, Conn.	$2,000,000
Buildings at Camarillo State Hospital, Camarillo, Calif.	$585,000
Highways, Texas	$613,000
Highways, Texas	$680,000
Highways, New York	$887,000
Detroit River Interceptor Sewer, Section 8, Detroit, Mich.	$1,340,000
Pumping station and grit chamber, Divisions 2 and 4; sedimentation tanks, Division 3, Buffalo, N. Y.	$1,714,000
Relaying 350 mi. track and 40,000 tons rails and fittings, Union Pacific Railroad, Omaha, Nebr.	$11,000,000 est.

New capital for the week totals $5,364,000; state and municipal bonds, $4,588,000 and corporate security issues, $776,000.

CONTRACTS
(Thousands of Dollars)

	Weekly Dec. 1935	Average Prev. 4 Weeks	Week Dec. 17 1936
Federal Government	$14,735	$8,154	$1,466
State and Municipal	37,038	23,597	15,620
Total public	$51,773	$31,751	$17,086
Total private	7,103	25,217	22,767
Week's total	$58,876	$56,968	$39,853
Cumulative to date: 1935	$1,525,844,000	1936	$2,293,969,000

NEW PRODUCTIVE CAPITAL
(Thousands of Dollars)

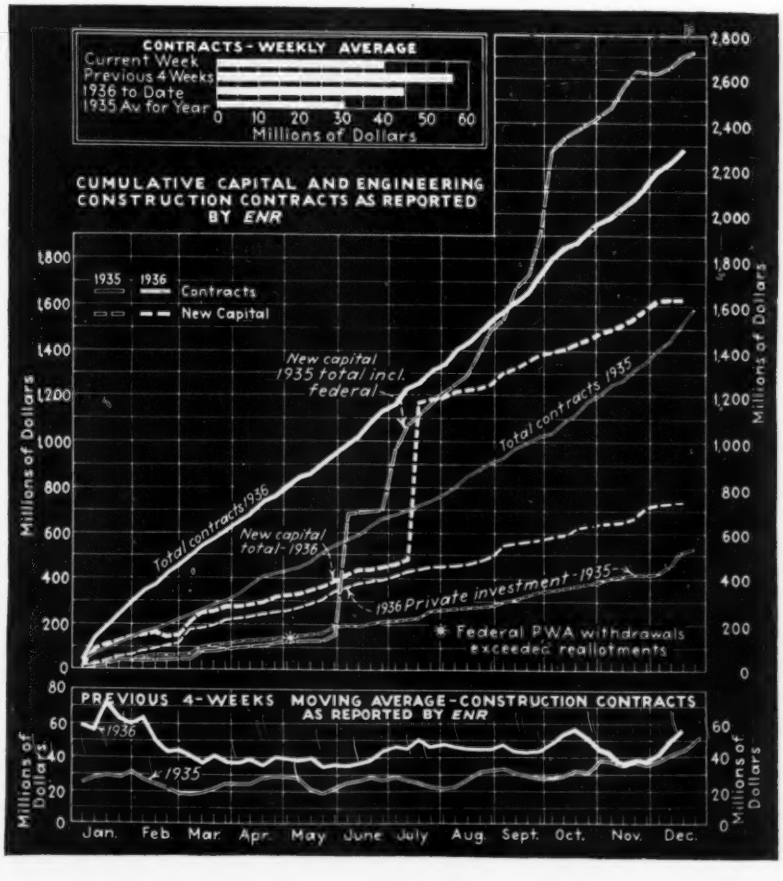
1936	Week Dec.17	Cumulative
State and municipal	$4,588	$495,498
PWA non-federal	.....	164,727
RFC loans	.....	26,663
Corporate issues	776	244,278
PWA loans, Private	.....	—1,665*
Total Non-Federal	$5,364	$929,501
Federal	.....	691,237
Federal	.....	.....
Total new capital	$5,364	$1,620,738
Cumulative to date: 1935	$2,699,536,000	1936	$1,620,738,000

*** Bond sales in this classification exceed reallotments during current year.**

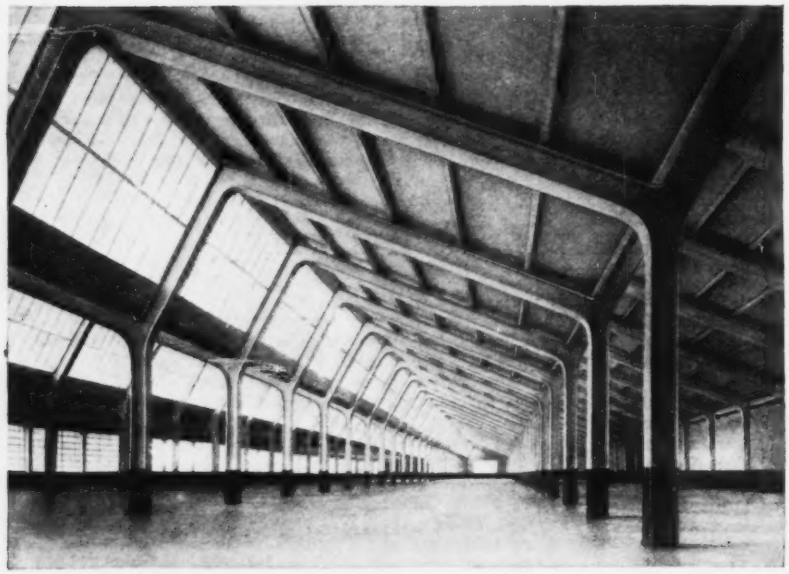
Note: These figures include private bonds, and stocks sold for productive purposes; state and municipal bonds for construction; PWA loans and grants to states and municipalities. RFC direct purchase of bonds for "self liquidating" projects, and 25 per cent of WPA construction appropriations.

INDEX NUMBER

ENR Cost	1913 = 100	1926 = 100	ENR Volume	1913 = 100	1926 = 100
Dec., 1936	220.67	106.07	Nov., 1936	159	70
Nov., 1936	212.70	102.24	Oct., 1936	178	78
Dec., 1935	194.90	93.69	Nov., 1935	171	75
1935 (Av.)	195.22	93.84	1935 (Av.)	135	58
1934 (Av.)	198.10	95.23	1934 (Av.)	114	50
1933 (Av.)	170.18	81.80	1933 (Av.)	102	47


CONTRACTS - WEEKLY AVERAGE
Current Week
Previous 4 Weeks
1936 to Date
1935 Av for Year
0 10 20 30 40 50 60
Millions of Dollars
CUMULATIVE CAPITAL AND ENGINEERING CONSTRUCTION CONTRACTS AS REPORTED BY ENR
1935 1936
Contracts
New Capital
New capital 1935 total incl. federal
Total contracts 1935
Total contracts 1936
New capital total-1936
1936 Private investment-1935
* Federal PWA withdrawals exceeded reallotments
Millions of Dollars
PREVIOUS 4-WEEKS MOVING AVERAGE - CONSTRUCTION CONTRACTS AS REPORTED BY ENR
1936
1935
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.

Construction Equipment and Materials



MODEL of a welded rigid frame and saw-tooth roof industrial building.

New Sawtooth Roof Eliminates Trusses

A new design for single story industrial buildings, providing broader factory aisles, unobstructed headroom to full ceiling height, and maximum uniform daylight throughout, has been developed by the Austin Co., industrial engineers and builders, of Cleveland. Entirely stripped of the cross members and trusses, which cast spider-web shadows across most factory areas today, the new type has a continuous rigid sawtooth frame, formed by the welding of rolled sections, which permits economical construction of aisles up to 50 ft. in width. According to Albert F. Low, vice-president and chief engineer of the Austin organization, the advantages of sawtooth construction have long been recognized, but until now have been confined to the glareless qualities obtained by facing monitors to the north. With all non-functional members eliminated, the new roof gives unobstructed space for ventilating or air conditioning ducts, pipes, and other equipment.

Street Lighting Unit Features Aluminum Reflector

Reflectolux, Jr., the new street lighting luminaire recently developed by the Westinghouse Electric & Manufacturing Co., of East Pittsburgh, incorporates a heavy aluminum reflector in an assembly which is said to be completely dust and weather-proof.

The luminaire consists of a canopy, reflector, globe holding ring, and globe. The canopy contains facilities for attaching several different types of lamps. The reflector is spun from thick Alclad aluminum to which an Alzak finish is applied after fabrication. The heel of the reflector is 5⅛ in. in diameter, large enough to clear a 500-watt lamp, the largest for which the luminaire is designed. Additional aluminum reflectors for non-symmetric distribution of light, are mounted inside the main reflector and integral with it. The globe is of rectilinear design and is held to the reflector by means of a globe band, in whcih it is seated in a gasketed recess.

The Reflectlux, Jr. luminaire is opened by loosening a thumbscrew in the canopy, which unlocks the bayonet arrangement by which the reflector is held. The reflector and globe assembly is removed as a unit.

The height of the unit is 22¾ in. and its diameter is 13⅜ in.

New Publications

✦A folder describing the application of *Variable Speed Motor Drives and Transmissions* to sewage treatment plants is put out by the REEVES PULLEY CO., of Columbus, Ind.

✦Two bulletins, *Nos. 1540 and 1550*, of the BLAW-KNOX CO., of Pittsburgh, Pa., describe the features of their bottomless scrapers and sheepsfoot rollers.

✦The results of a research program on a technique for the *Welding of Wrought Iron* by the A. M. BYERS CO., of Pittsburgh, Pa., are incorporated in an attractive 11-page booklet.

✦The *Worthington Rock Master*, a light weight portable drill, is described in a bulletin of the WORTHINGTON PUMP & MACHINERY CORP., of Harrison, N. J.

✦The AMERICAN COLLOID CO., Chicago, have published *Water Impedance with Volclay Bentonite*, a treatise on the properties and uses of Bentonite.

✦Two bulletins from the PRECISION SCIENTIFIC CO., of Chicago, *PS 3000* and *PS 3110* give instructions for operating their gas meters and calorimeters.

✦The *Things You Should Know About Your Roof*, according to the JOHNS-MANVILLE CO., of New York City, are the proper and the improper types of workmanship at the critical boundary points.

✦R. C. STANHOPE, Inc., of New York City have issued their 1937 list of the *Available Equipment, Machinery and Steel Products.*

✦The use of Monel metal in engineering structures is described in a handsome new publication of the INTERNATIONAL NICKEL CO., of New York City, *Strength Plus.*

✦A group of five handsome booklets, entitled, collectively, *Enduro*, describe in text and tables the properties of a number of the alloy steels produced by the REPUBLIC STEEL CORP. of Cleveland, Ohio.

✦The *Autobiography of a Hercules Electric Blasting Cap*, published by the HERCULES POWDER CO., of Wilmington, Del., describes in pictures and brief text the manufacture and testing of that company's blasting caps.

✦*Permite Ready Mix Aluminum Paint* is described in a strikingly printed booklet put out by ALUMINUM INDUSTRIES, INC., of Cincinnati, Ohio.

✦The PRODUCTIVE EQUIPMENT CORP., of Chicago, Ill., in their booklet, *Selectro*, describe the features of their mechanical screens.

✦A loose-leaf portfolio, *Hume Pipe*, put out by the DETROIT HUME PIPE CO., of Detroit, Mich., describes their centrifugally cast reinforced concrete pipe. Besides some attractive photographs, the portfolio includes flow tables, cost figures and methods for the computing of external pipe loads.

✦Specifications and properties of *Stanton Spun Iron Pipe* form the subject of a 16-page booklet issued by the STANTON IRON WORKS., of Nottingham, England.

✦*Wired rope connectors* are described in a small booklet published by the ELECTROLINE CO., of Chicago.